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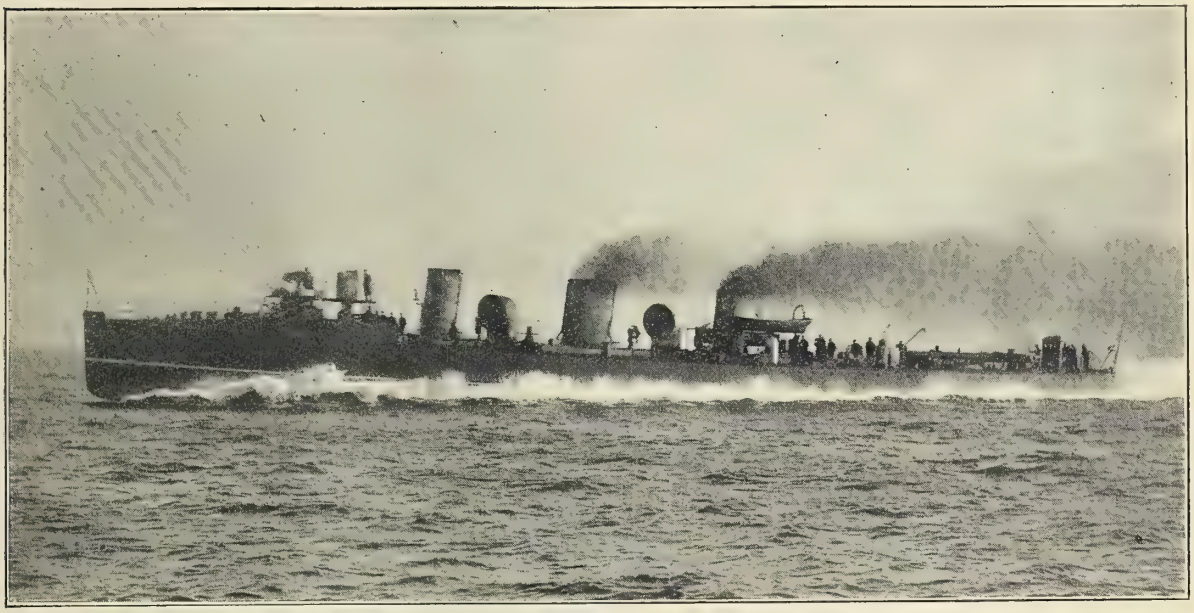
FURTHER TRIALS OF THE TURBINE DRIVEN TORPEDO BOAT DESTROYER VIPER.

In a series of runs over the measured mile carried out last month the turbine driven torpedo boat destroyer *Viper* maintained an average speed of 34.25 knots. The trial conditions were not favorable; there was a rough sea, the wind was "blowing hard," and as the boat had not been out of the water for some time previously, her under water body was rather foul.

The *Viper*, as our readers will recall, was built by Hawthorne, Leslie & Co., and was engined by the Parsons' Marine Steam Turbine Co., Newcastle-on-Tyne, for the British Navy. On her builders' trials a speed of 35 knots was attained, and she was then turned over to the navy for further trial and acceptance. It is, we understand, the intention to not only carry out acceptance trials, but to make a very exhaustive series of trials with the *Viper*, so as to get a line on the turbine method of propulsion in general. The trials here referred to were carried out by representatives of the Admiralty.



OCTUPLE SCREW TURBINE DRIVEN DESTROYER VIPER DOING 35 + KNOTS ON HER PRELIMINARY TRIAL.

In the accompanying photograph the *Viper* is shown steaming at the rate of about 35 knots, on her preliminary trial. In dimensions she measures: Length, 210 ft.; beam, 21 ft.; depth, 12 ft. 9 in. The vessel is fitted with four separate screw shafts, on each of which there are two propellers. The inboard end of each shaft is direct connected to a separate turbine. These are fitted in pairs, and the high and low pressure turbines of the two independent sets of compound turbines are separate. The high pressure turbines are 35 in. dia. and the low pressure 50 in. dia. These main engines are for steaming "ahead" only, as they are not of the reversing type, and the sternward moving of the vessel is accomplished by the use of a separate turbine connected to one of the shafts. With the "ahead" turbines stopped and the "astern" turbine in operation, a maximum rate of speed sternward of 15 1-2 knots can be attained.

In exterior appearance the *Viper* does not differ from the ordinary destroyer. She has three stacks, the middle one being larger than the other two; this is necessary, as the two center boilers are placed back to back. The boilers are of the Yarrow straight tube express type. They have 275.75 sq. ft. grate surface and 15,000 sq. ft. heating surface.

On the trials last month the contract load of 40 tons was increased to 60 tons, and the displacement is stated to have been 375 tons. Steam was maintained at press-

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ures ranging from 165 to 175 lb., as higher pressure could not be carried on account of the setting of the relief valves, which lifted when the pressure was allowed to run up. The mean revolutions on the mile were about 1,050, and at the boilers the air pressure carried was about 3 in. Indicator diagrams cannot, of course, be obtained with this form of engine, but it is estimated that the horse power was not less than 11,000. After completing the runs over the measured mile, a three hours' steaming trial was successfully carried out.

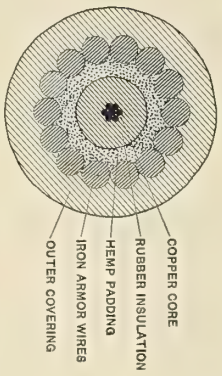
It is in the engine room, of course, that the difference between the *Viper* and the ordinary destroyer is most noticeable. Instead of the usual complicated reciprocating engines standing up in the engine room, with hundreds of moving parts in sight, there is nothing visible except the casings of the turbines and the condensers. The high pressure ends of the engines are forward, below the starting platform which stretches athwartships. There is no valve gear nor complication of starting levers, simply the stop valves on the live steam mains, by which alone the starting and stopping of the turbines are regulated.

When running at all speeds the absence of vibration, as far as the main engines were concerned, was remarkable as compared with a boat fitted with reciprocating engines. All noise and vibration was not eliminated, however, as the auxiliaries are of the ordinary type. It has been proposed by the builders to get rid of this by installing the electric drive, the generators to be driven by a steam turbine.

Results of further trials with this interesting vessel are awaited with very great interest by members of the profession in every maritime country.

CABLE CUTTING OPERATIONS OF U. S. S. ST. LOUIS DURING THE SPANISH WAR.*

BY CAPT. CASPAR F. GOODRICH, U. S. N.



SECTION OF CABLE—EXACT SIZE.

On the 30th of April, 1898, the U. S. S. *St. Louis* left New York to scout off the island of Guadeloupe in the hope of sighting Cervera's fleet. While engaged in this duty many conversations were held by her officers as to what the ship might do during the war which would be useful to the country, and as to the various means by which our own cause could be advanced or the enemy's injured. Some one, I have forgotten now who it was, remarked that Admiral Sampson would greatly appreciate the cutting of the submarine cables leading to Cuba and Porto Rico, adding that a cable ship was now a necessary part of any well-organized fleet.

"Not at all," said Chief Officer Segrave; "there is nothing easier than to pick up and cut a cable."

At this the rest of us exclaimed: "How is it done? Can you do it?"

Mr. Segrave replied: "All you have to do is to lower a stout grapnel to the bottom and to drag it slowly across the location of the cable. If the bottom is sandy and free from rocks you can often catch the cable on the first drive. If, on the other hand, the bottom is foul, you may spend a week and not get it, even when you have special appliances for the purpose."

Marine Engineering

OUTLINE MAP SHOWING THE FIELD OF U. S. CABLE CUTTING OPERATIONS DURING THE SPANISH WAR.

It will be recalled that in addition to the *Viper*, for the British Government, another vessel of similar dimensions was constructed, the owner's identity not being disclosed. This boat, named the *Cobra*, has just been completed, and according to cable reports, she attained a rate of speed of 35.88 knots.

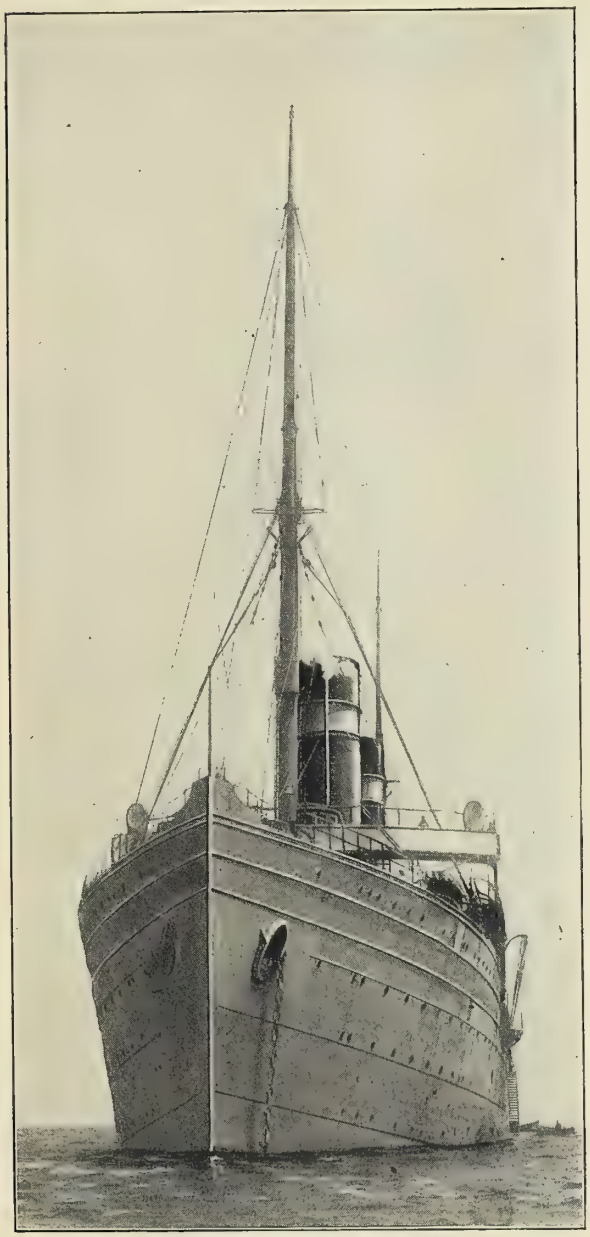
*From the *Proceedings of the U. S. Naval Institute;* Text Copyright, 900, by the U. S. Naval Institute, Annapolis, Md. Illustrated by MARINE ENGINEERING.

"How do you happen to know so much on the subject?"

"I have spent years laying and repairing cables. I have, myself, laid some of the cables now in the West Indies."

"Could you pick up cables in so large a ship as the *St. Louis*?"

"Why not? It is only a question of devoting a big and valuable craft to work which might equally well be done by a small steamer."



AMERICAN LINER IN WARTIME—BOWS ON.

"Would you like to try for those leading to Porto Rico?"

"Very much indeed."

We ran into Guadeloupe on May 11, and I immediately telegraphed to the Navy Department and to the Commander-in-Chief: "Unless I receive orders to the contrary, I shall destroy the two telegraph cables to San Juan, Porto Rico, which my first officer has laid [in] shallow, navigable waters." That evening the ship proceeded to St. Thomas, where instructions to join the admiral's flagship at the stated rendezvous off Cape Haytien, and at a stated hour were given me. Orders *not* to destroy cables never came to me because they were never sent.

We learned at St. Thomas, in ways which it is not well to divulge, that the cable from San Juan to Jamaica was out of order. To isolate Porto Rico, therefore, it would be necessary to cut the St. Thomas-San Juan line and the alternate lines leading out of Ponce to Jamaica and to St. Thomas. As time permitted, we decided to cut the first of these three lines way to the flag.

It is always surprising to find out how hard is the obtaining of any exact information on any given subject. We have all had this experience. Generalizations abound, but when one wants accurate knowledge every topic is seen to bristle with difficulties and to be shrouded in mystery. Cable-cutting is no exception to the rule. Now there are two important conditions essential to success in this operation. In the first place, you must know where the cable lies; and, in the second, how to pick it up. I think it may be broadly stated that, outside of the records of the proprietary cable company and excepting as to some shore ends, the precise location of every cable is unknown. No chart that I was able to obtain, no source of intelligence, could tell me the very spot to go for the purpose of raising the submarine wires I wished to sever. True, there are many charts indicating the presence of such lines connecting various ports, but they are all schematic only. To follow such a diagram closely in the belief that it will lead to the particular point sought would be a waste of time. There is one consideration, however, which is always useful as a guide. Cables are costly. Even the deep-sea portions, which are lighter than the shore ends, are expensive, the price running from $500 per mile upwards. It may therefore be confidently assumed that where the water is over 20 fathoms in depth and consequently quite undisturbed by heavy gales of wind, the company will follow the shortest distance between the terminal points, which, in sweeping around an irregular and salient shore, will pass, naturally, from headland to headland. For example, when wishing to pick up the Santiago-Jamaica cables, we drew on the chart the straight course connecting the harbor mouth with Holland Bay, Jamaica, where the cables land, and we were confident that what we sought would be found, if at all, not far away. As a matter of fact we got the cables just where we reasoned that they must lie. But how much more satisfactory it is to know in advance where the cable was originally placed, and how fortunate I was to have at my disposal a man who had placed it there himself and knew how to go about grappling for it.

The process of grappling is very simple in the abstract. Over the *bow*, you lower a grapnel to the bottom and then steam very slowly ahead—barely moving the ship—square across the line of the cable. The grapnel creeps over the bottom, its prongs burrow-

ing slightly under the surface of the soil until they catch underneath the cable. The gradually increasing tension on the grappling rope reveals to the expert, whose hand is always on the outboard part, that the cable is caught. The movements of the ship are under his control by signals to the bridge, and he measures the speed by the old device of the Dutchman's log—billets of wood thrown overboard from time to time. It is well to keep going ahead for a few minutes after getting an unmistakable "bite" in order to lift the cable off the bottom and thus insure its being well hooked. Then the ship is stopped, the line taken to a steam capstan or winch and hove in. As soon as the bight is well out of water a hawser is bent to it and the grapnel relieved of its duty. When the cable is inboard a stout plank to protect the deck, a couple of sharp blows with an axe, and the thing is done. Letting one end go and steaming a couple of miles away with the other, make a gap of sufficient magnitude to embarrass the repair steamer, should she come along before peace is declared.

Practically, much depends on the judgment and experience of the operator. He knows when it is best to put a shot of 3-4 in. chain just ahead of the grapnel; when best to use manila; when ordinary wire is advisable. For deep-sea work, in 1,200 fathoms or upwards, a special steel rope has been developed, very strong, very light, very flexible, its outer strands wrapped with hemp yarns. The "feel" is so much deadened that with improvised appliances you might catch and part a cable in such a depth of water and be never the wiser; or, you might miss it and think you had broken it. It is the old story—sooner or later in any particular branch of human activity we must abandon makeshifts, use standard appliances, and call in the professional.

The conditions I have just described are those most commonly found—a comparatively smooth sandy or gravelly floor. For such conditions the outfit mentioned will suffice, with patience and care.

But cables often lie on rocky bottoms; possibly they run between boulders or coral heads that protect them from the searching prong of the grapnel which engages under one rock only to spring, when freed, clean and clear over the modest retiring wire, or to have its prongs straightened out to a state of flabby uselessness. Here a cable is as safe as if buried in a trench except for the one chance out of a thousand which favors the grappler. Under these circumstances, recourse is had to one or more so-called centipedes. Imagine a piece of 5-in. or 6-in. lap-welded iron pipe, about 3 ft. or 4 ft. long. A series of square holes is cut in this pipe, each pair at opposite ends of a diameter, the diameters being placed spirally along the length of the pipe. Through each hole and its opposite, square pieces of iron or steel are driven and the ends turned forwards towards the ring by which the instrument is towed. This is a centipede. It always has for its leader a length of chain. Two or more centipedes with their leaders are occasionally bent tandem to the same line. Perseverance and repeated trials are necessary even when centipedes abound. In cable practice it is sometimes considered economical to abandon altogether a leaky wire and to replace it with a new one rather than attempt to raise and repair it in such a foul bottom.

While on this branch of the subject I may remark that the two cables from Santiago to Cienfuegos come under the head of cables protected by the nature of the bottom. We made altogether in the *St. Louis* and the *Suwanee* no less than fourteen drives for them at points varying from just outside the harbor mouth at Santiago to ten miles distant, but we never succeeded in getting the wire or in bringing up anything more than the grapnel itself with its prongs straightened out like the ribs of an inverted umbrella. The Santiago-Cienfuegos cables were our conspicuous failure.

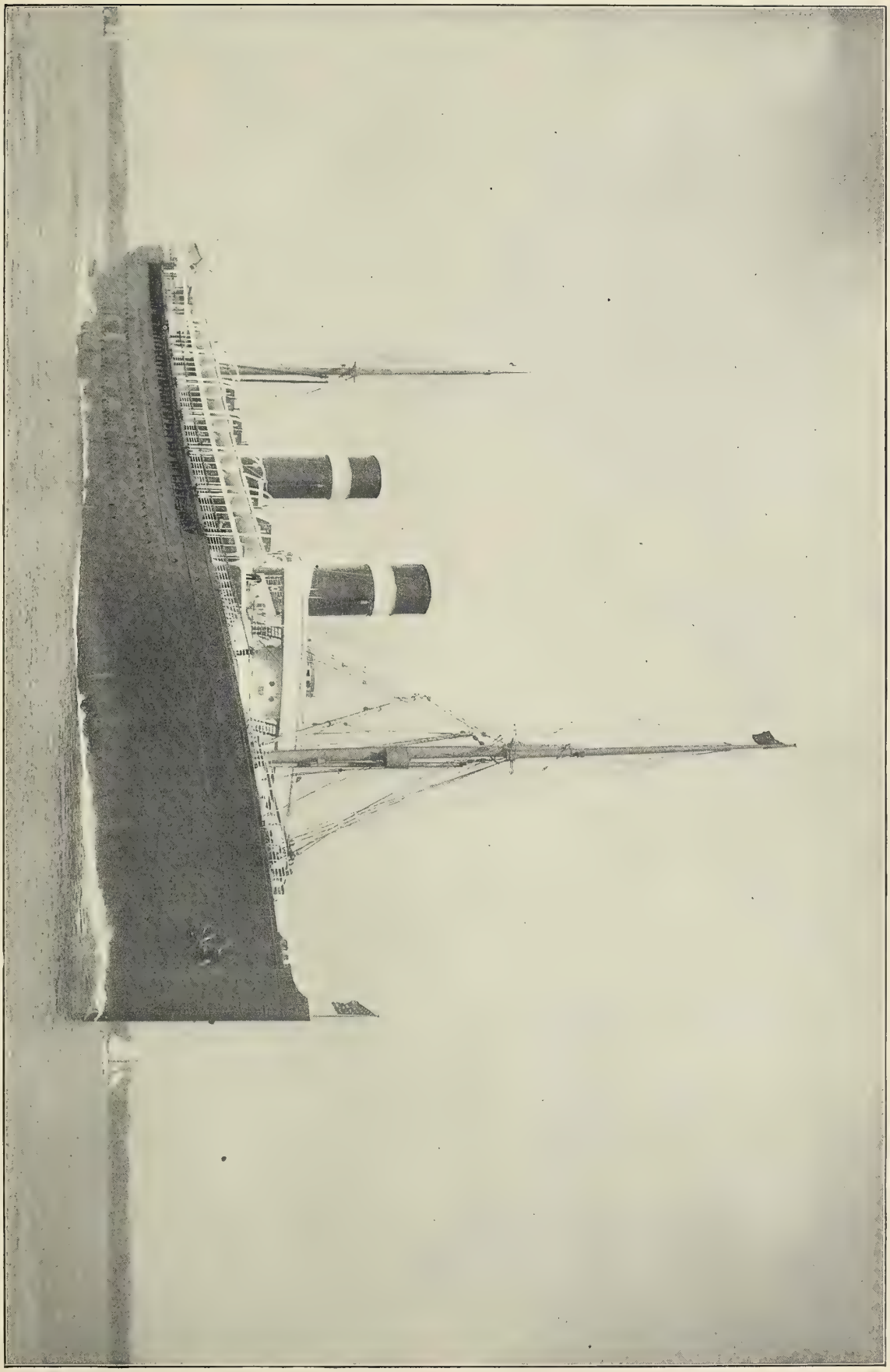
On the 13th of May the *St. Louis* broke the San Juan-St. Thomas cable. It was necessary to go quite close to the beach about eight miles east of San Juan—and great was the excitement created on shore by our approach. Horsemen could be seen riding frantically in all directions, doubtless to summon troops to resist or friends to facilitate an assumed landing on our part. Not being able to determine which was the actuating sentiment, friendship or enmity, we refrained from firing. The grapnel opened out in this drive, but it brought up enough of the gutta percha insulation and of the protecting hemp to justify us in believing that the cable was actually parted, corroborating the evidence of the heavy strain and sudden release of tension.

When, next morning early, I reported to Admiral Sampson, on board his flagship, both what I had done and what I thought I could do, he expressed his great satisfaction and he quickly adopted my suggestion that the *St. Louis* continue the work she had begun. Chief Officer Segrave was summoned over from the *St. Louis* that he might explain to the admiral his requirements in the matter of lines and grapnels. A number of manila hawsers of 6, 7, and 8 in. circumference, and a lot of stout grapnels were delivered to us by the fleet. For inshore work, where light draught and handiness were necessary, the admiral was good enough to assign to my assistance the U. S. S. *Wompatuck*, commanded by an excellent, faithful, and brave officer, Lieutenant Carl W. Jungen, U. S. Navy.

When such preparations were completed as the resources of the fleet permitted, the *St. Louis*, displacing over 17,000 tons, the largest vessel, by the way, which ever wore a pennant, and her little consort, the *Wompatuck*, of 462 tons displacement, steamed away from the flag toward Santiago de Cuba, our first point of attack on the enemy's submarine communications with Cuba.

The following day, the 15th of May, was spent in the Windward Passage, out of sight of land, in fitting up the *Wompatuck* for grappling, furnishing her with steaming water, etc. It was determined that an attempt on the Santiago-Jamaica cables should be made by that vessel May 16, and we timed our movements so as to arrive off the port about 9 P. M.

The night was appropriate to the work, being moonless, but clouds with mist and rain would have been still more acceptable as obscuring us from the enemy. Such as the weather was, however, the stars shining brilliantly in the calm air, we had no choice but to go in and run the risk of detection. Accordingly, a volunteer party from the *St. Louis*, with Chief Officer Se-



Photograph copyright by West & Son, Southsea.

AMERICAN LINER ST. LOUIS (STEAMING FULL SPEED AHEAD), WHICH AS THE U. S. AUXILIARY CRUISER ST. LOUIS CARRIED OUT SUCCESSFULLY CABLE-CUTTING OPERATIONS DURING THE SPANISH WAR UNDER COMMAND OF CAPT. CASPER F. GOODRICH, U. S. N.

grave at its head, went on board the *Wompatuck* with me. They were not, as yet, formally enlisted or commissioned in the United States Navy, were, in fact, only under charter to the Government by the American Line, and thus lay under no positive obligation to endanger their lives in a military enterprise.

The *Wompatuck* approached the port from the westward, hugging the land and stealing slowly toward the Morro, which soon towered above her. We were at the very mouth of the harbor. Lowering the grapnel quietly, we soon had hold of a telegraph cable, and then the heaving-in process began. In spite of our precautions some noise must have been made, for a patrol boat came out toward us. Supposing that the Morro, which was close to us, mounted guns, and believing that our presence, now known, would bring a reinforcement sufficient to deprive us of the four or five hours necessary to grapple, raise, and cut both Jamaica cables, I decided to abandon the attempt that night and try to reach my end in another way. We returned to the *St. Louis*, which lay in the offing, and learned that during our absence she had been chased by two patrol vessels flashing signals to each other. We then steamed well out of sight to the southward and westward.

On the 18th of May the *St. Louis* and *Wompatuck* came from the westward toward Santiago at daylight at the distance of a mile or so from the beach. At 5 A. M. we were within range of the batteries. The Morro fired a gun to give warning of our approach, and we supposed that it would be followed by a general opening of fire upon us. In this we were agreeably disappointed.

The water is so deep off Santiago that it was necessary to pass quite close to the batteries in order to reach bottom with our grapnel. When on a predetermined line of bearing from the lighthouse we lowered down not far from a thousand fathoms of hawser and began the slow work of feeling for the cable. It was not until after 11 A. M., if my memory serves me rightly, that the *St. Louis* hooked her fish and could heave in. In the meantime, great activity and excitement prevailed on shore. Steamboats plied between the Morro and the city bringing troops and carrying away passengers, whom we took to be women and children. At the Socapa battery and at that to the eastward of the Morro, men were working like beavers to get guns into position. It was evident that the Krupp 6-in. B. L. R.'s we had been told of as in place were not ready. Still no effort was made to disturb us, and I doubt whether, for a long time, the Spaniards suspected our object. At about noon, however, we had begun to lift the cable. Word to that effect must have been sent to the officer in command from the cable station, for the Spaniards opened on the ship—the lighthouse being then distant a mile and a tenth by observation. The shots were not well directed, however. We had no difficulty in shortly driving the gunners from their pieces near the Morro, or in seeing them as they ran away.[1] The *Wompatuck*, which had been lying well outside of the *St. Louis*, came up in great shape and joined in the action. The total broadside of the American ships in this fight was two 6-pounders on board the *St. Louis* and one 3-pounder on board the *Wompatuck*.

The battery of rifled mortars on Punta Gorda gave me much concern, for it was entirely out of reach of my little guns and yet was able to drop its shells all around us. We were practically a stationary target, for the *St. Louis* was fast to the cable. We could not make up our minds to let that go, so we stuck to it and hove it up. Once the bight was secured we could steam away as we liked. It was a great relief to me when the valuable and most vulnerable ship I commanded had put the western point of land between her and Punta Gorda. We were some forty odd minutes under fire—and exposed to large shells sent from guns beyond our range, whose accuracy of aim became painfully threatening. However, "All's well that ends well." We got the cable; we fought the Spaniards; and we silenced the guns that were within our range; and we escaped unhurt.

The next day we made an unsuccessful attempt to cut the French cable at Guantanamo, which we cut the day following, outside the Mole St. Nicholas. At this the *Wompatuck* left us to join the flag at Key West.

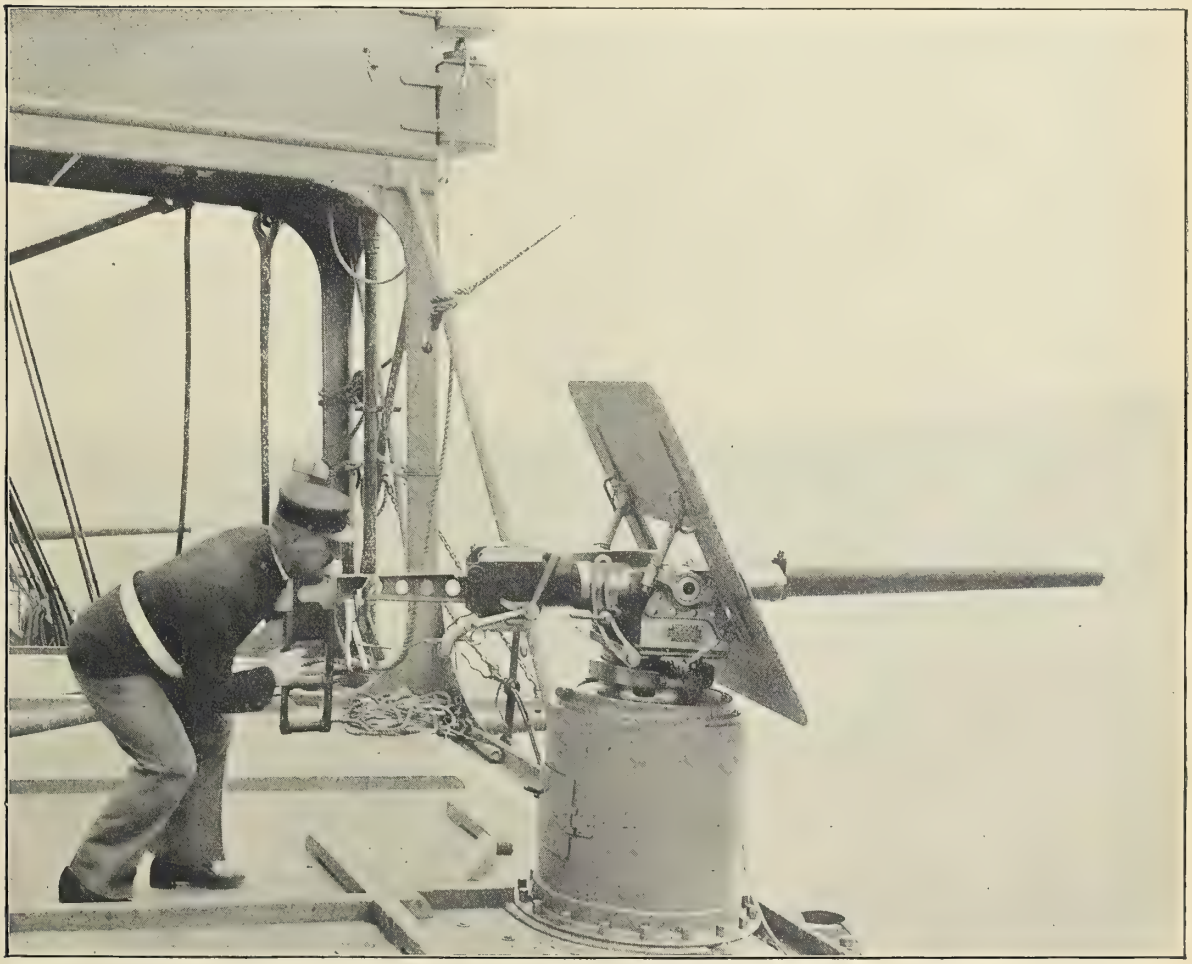
The rough coral bottom off the south side of Porto Rico frustrated our subsequent efforts to isolate that island and demonstrated the need of special tools.

I have spoken already of my repeated failures to get the Santiago-Cienfuegos cable by which Havana communicated with Santiago. On two of these occasions we got at night close into the beach under the Socapa battery, once in the *St. Louis*, when there were but 12 fathoms of water under her bow, which lay just outside of the surf. Why the Spaniards did not blow the big liner out of water surpasses my comprehension. She offered an ideal target, her huge bulk plainly outlined as a silhouette against the background of a searchlight beam behind her. Again, in the *Suwanee*, on June 16, I got even closer still—so close that Lieutenant Aranco, of the Spanish Navy, vainly begged the gunners to open fire on us, for he could both see and hear us distinctly. Probably Lieutenant-Commander Delehanty, who commanded the *Suwanee*, would have rejoiced in being fired at. For myself, I frankly confess I am glad the Spanish commandant rejected Aranco's proposition.

About this time the Army Signal Corps was vainly endeavoring to get the remaining Santiago-Jamaica cable—the one which it seems the *St. Louis* had left intact on May 18, although I had reason at the time to believe it broken. The corps had chartered the cable steamer *Aldria*, fully equipped for such work while I had furnished all the information in my possession, had described how and where I had grappled number one, and what measures I should take to secure number two. As far as I could I aided in every way. Among other things I had strongly advised steaming across the line of the cable from east to west, for I had towed the broken ends of number one to the westward, leaving the eastern approach clear. Any cable picked up to the eastward would, therefore, in all probability, be a live cable.

[1] In the table of bombardment of Santiago given by Commander I——, *Proceedings Naval Institute*, March, 1899, p. 29, it is stated that a 16-cm. gun at the Morro "could only fire three shots." It appeared to us on board the *St. Louis* as if the cause lay rather with the gun's crew, which certainly, to a man, sprinted in fine form.

MORRO AT ENTRANCE TO SANTIAGO HARBOR—LIGHTHOUSE TO THE RIGHT ON SLOPE OF HILL.



RAPID-FIRE GUN MOUNTED ON AMERICAN LINER (AUXILIARY CRUISER) ON THE BOAT DECK CLOSE TO THE BRIDGE.

Provided thus with all the counsel and knowledge at my disposal, the cable steamer, under the Signal Corps, made one last and dramatic effort—passing over the line with the *Oregon* and *Texas* between her and the batteries. To make a long story short, she went from *west* to *east* and she did not get the cable then or at any other time.

On the night of June 18 the admiral allowed the *St. Louis* to try for the remaining cable. Starting in after nightfall and proceeding from *east* to *west*, she picked up and severed the cable without difficulty or loss of time. From that date on no telegraphic messages passed out of Cuba via Santiago.

The *St. Louis* cut the French cable from Guantanamo to Santiago on June 7, and the same day she grappled that from Guantanamo to Mole St. Nicholas. By the admiral's orders the latter was not cut, but about 10 in. of the conductor were removed, and the injured place buoyed. The idea was to have this line only temporarily disabled and ready for subsequent use with but slight repairs. It is an interesting fact that for several hours afterward messages were sent and received over the damaged line. The moral is that if you want to stop the enemy's use of a cable you must completely sever it and separate the ends.

It was Chief Officer Segrave who put us in the way of cutting cables and who actually cut three, viz., San Juan-St. Thomas, the first Santiago-Jamaica, and the Guantanamo-Mole St. Nicholas lines. It was his temporary successor, Chief Officer George E. Beckwith, who cut the two cables which formed the loop on the Santiago-Hayti section, leading into and out of Guantanamo—a most difficult job it was, too—and also the last Santiago-Jamaica link. They both bore commissions in the navy of the United States, and well had they deserved them.

The *St. Louis* thus cut *every* foreign cable leading to Cuba and established an honorable name in connection with work which could hardly have been in the minds of her designers when they drew the plans of so noble a vessel, distinguished in war as well as in peace.

It would be unfair if I brought this brief sketch of events to a close without recording my appreciation of the loyalty and pluck of Commander Randle, previously and subsequently the worthy commodore of the American Line, who was the sailing master of the *St. Louis* during the war when not actually in command of her, and my indebtedness to his zealous and never-failing co-operation. In all this he was imitated by the officers and men who served directly under him and who speedily set up a healthy rivalry in all good things with "the regulars" on board composed of my aid, Ensign F. R. Payne, Lieutenant A. W. Catlin, U. S. M. C., and his excellent guard of marines, not to mention four naval cadets of the third class at the Naval Academy, Messrs. Fremont, Williams, Cook and Goodrich.

Marine Barracks, Navy Yard, Brooklyn, N. Y.
November 15, 1898

I certify that on August 10, 1898, I landed at the cable station at the entrance to Santiago Harbor, and had a conversation with the operator. During the conversation the operator informed me that no news had been received or sent over the Jamaica-Santiago cable since the 18th of June, the night when the *St. Louis* cut the last cable in front of Santiago.

A. W. CATLIN,
First Lieutenant, U. S. M. C.

Cambering of Steamship's Keels.

A very important decision was given in the British House of Lords, sitting as a Court of Appeals, recently, in a suit in which in the lower court Burrell & Son, shipowners, had sued Russell & Co., shipbuilders of Port Glasgow, Scotland, to recover damages for faulty construction of four cargo steamships. Judgment was delivered by the Lord Chancellor in favor of the shipowners, after a prolonged hearing which extended over eleven days.

Stripped of its legal impedimenta the cause of action was this: A contract had been made in 1893 between the parties for the construction of four steamships of large size for which the usual specifications and outline plans had been prepared. In due course the steamers were completed and accepted by the owners without complaint. About a year afterward they brought suit against the builders for $200,000, alleging that the vessels had permanent cambers or arches in their keels, which added to the risk and cost of docking them, and also that the co-efficient of fineness contracted for had been greatly exceeded. It was contended that though the contracts did not specify that the vessels were to have straight keels, it was the universal practice to so build steamships—a contract for building a house did not specify that the walls should be plumb—and the plans and models showed keels of the usual form. In response the builders had replied that the cambering of keels was not unusual; that this was done with the cognizance of the owners, and that the vessels had been accepted by the owners in full knowledge of the camber, of the draft, and of the co-efficient of fineness.

At the original hearing the Court of Sessions assoilzied the respondents (Russell & Co.), and the appeal to the court of last resort (House of Lords) was taken.

In giving judgment for Burrell & Son, the Lord Chancellor said the original contract was in writing, and no dispute had arisen as to the construction of it, and by its "express language" the plans were made part of the contract. It had not been suggested that the ships should have cambered keels when in service, though evidence had been introduced to show that in the actual process of building and in order to produce a straight keel, a small camber might be devised so as to counteract the tendency of "sagging." Speaking of one of the vessels as representing all, his Lordship said, that at the time of the contract it was the largest cargo vessel in the world, and the contract price was upwards of $800,000. It was not denied that giving this vessel a camber at all, as a steamer and not as a sailing ship, was an experiment. It was strange that so serious an experiment should not be the subject of a single sentence of the written agreement, while matters of much less consequence were referred to minutely, and the evidence showed that the attention of the owner to this serious question was called only in a casual conversation ("a few words") on a staircase.

Getting to the bottom of the matter, the Court says that a mistake had originally been made by a leading draftsman in the employ of the builders with reference to the carrying capacity, and in construction the cambering was intended to compensate for that mistake. The camber amounted to 8 in. or thereabouts. The plans had been altered subsequently by this draftsman

so as to make it appear that the vessels were not originally designed with straight keels. As to the co-efficient of fineness, evidence showed that this was .781 instead of .770, as contracted, making a difference of 120 tons to 170 tons in the carrying capacity.

Coming to the question of damages, his Lordship held that the expense of remedying the camber was not all to which the owners were entitled. It was proved that a vessel with a false keel was not as good a marketable article as a vessel without that defect. It was proved also that the contract co-efficient of fineness had been exceeded, and it was impossible to say that where skilled persons had stipulated for a particular co-efficient of fineness with reference to speed, symmetry, and economical draft of the vessel, a breach of contract in that direction could be regarded as altogether immaterial, and to be only treated as though the damages in respect of the breach were merely nominal. Taking all the heads of damage together and the cost of the efforts to remedy the structural defects they would be right in assessing the damages at $80,000. He directed the entry of judgment for this amount and all costs of litigation against the builders. Lords MacNaughten, Morris and Davey concurred.

S. S. Deutschland.—Some time this month the magnificent new liner *Deutschland*, of the Hamburg-American Line, is expected to arrive at the port of New York on her first west-bound voyage. The dimensions of the new vessel are: Length over all, 686 ft. 6 in.; beam, 67 ft.; depth, 44 ft.; net tonnage, 16,000 tons; and displacement, 23,000 tons. Her machinery equipment is of special interest in that she will be fitted with the most powerful main engines afloat. These will be twin screw of the quadruple expansion, six-cylinder type, of 33,000 collective horse power, and a sea speed of 23 knots is expected. Steam will be furnished by boilers of the Scotch type, twelve double ended and four single ended, having altogether 112 furnaces. There will be four groups of boilers, each in its own fire room, and each having uptakes connected with a separate funnel. In general design the main engines are very like those of the American liners *St. Paul* and *St. Louis*, except that the framing back and front is composed of cast steel columns of I section, with the webs cored out for lightness. The cylinders are of the following diameters: H. P. (2), 30.6 in.; first I. P., 73.6 in.; second I. P., 103.9 in.; L. P. (2), 106.3 in. dia. and all of 72.8 in. stroke. The engines are designed with the two L. P. cylinders in the center, with the two H. P. over them tandem fashion, and the first intermediate at the forward end and the second intermediate at the after end. The new vessel will be equipped in the most modern and luxurious manner, having comforts for passengers such as children's playroom, grill room, and gymnasium, in addition to those usually provided.

S. S. Cape Cod.—The new wooden hull excursion steamer for the Boston, Plymouth & Provincetown Steamboat Co., was launched from the yard of A. D. Story at Essex, Mass., May 5. The new vessel is of the single screw type with three decks, and will have accommodations for 1,200 excursionists. Her machinery will be installed by Bertlesen & Petersen, East Boston, Mass.

WAGES PAID SEAMEN OF VARIOUS NATIONALITIES AT FOREIGN PORTS.

In our last issue we presented an abstract of the reports made by United States Consuls upon the wages paid in shipyards of foreign nations. We now follow this up with a table compiled from the same United States official report on the "Merchant Marine of Foreign Countries," showing the wages paid the crews of vessels at ports of the leading maritime nations. It is hardly necessary to say at the outset that all such tables must be intelligently used; for just as with a formula, the incorrect use of such data leads to conclusions more seriously in error than had no use been made of it. There is, however, a better opportunity to make direct comparisons between the wages paid seamen of different nationalities than those paid workmen in the shipyards of different nations. For whereas in the latter case the labor of one man in one country may be equivalent to the work of two or three of another country in the same space of time, the duties to be performed in a steam vessel level down the capabilities of different nationalities to much more of an average.

There is a direct competition in carriage by sea (operation of vessels) that does not exist to anything like the same extent in vessel construction. A merchant who brings his goods to the wharf can just as readily have them loaded upon a British or German vessel as on an American vessel. Then, under normal conditions, a vessel built to carry a certain tonnage at a certain speed can complete her voyage under the designed conditions whether the crew be of one nationality or another. From the points of view of maintenance and wear and tear there are recognized differences between the seamen of different nationalities, but so there are between the crews of the vessels of any one nation, and in the broad view of vessel operation such details can be overlooked so long as questions having vastly greater bearing on the prosperity of our merchant marine remain unanswered. Taking modern steam vessels as they run, wherever built, no nation possesses any great advantage over another as to the economical operation of the machinery. The most economical forms of propelling apparatus are standard, and where any royalties have to be paid they press just as heavily on one as on another, and the form of ships is as well understood, in general, in one country as in another. It is to the personnel, therefore, that differences in the cost of operation must be attributed chiefly. This is very well displayed in the accompanying table, which shows that Americans receive substantially higher wages than seamen of other nationalities for performing similar work.

A very direct comparison can be made between our leading steamship company—the American Line—and first-class British lines leaving the same English port of Southampton. The Royal Mail is one of the old established British lines to the West Indies and South America, and the Union Line (now consolidated with the Castle Line) to South Africa is one of the leading lines connecting the mother country with an important colony. Taking the head of the list, it will be noted that the chief officer of an American liner receives $120 a month, while on the other lines the maximum is $87.50 a month. An American Line chief

engineer receives $150 a month and the British engineer a maximum of $121.75; and coming down to firemen, a class with exactly similar duties in vessels of both countries, we find the American Line paying $40 a month and the other lines paying $23 a month. Able-bodied seamen on the American Line receive $25 a month and on the British mail boats $19.50 a month.

EQUIVALENT IN AMERICAN DOLLARS OF MONTHLY WAGES PAID

Country, Port, and Nationality of Seamen.	Captain.	Chief Officer.	Second Officer.	Third Officer.	Carpenter.
[1]AUSTRALIA—					
Melbourne		63.26—77.86	48.66—63.26		43.79
AUSTRIA—					
[2]Trieste :					
Austrian		38.92	24.32		17.03
British		58.38	43.79		29.19
German		28.56—35.70	23.80		19.04—21.42
Italian		43.75	30.62		11.38—14.00
BELGIUM—					
Antwerp :					
Société Anonyme Belge du Congo		62.72	38.60	28.95	28.95
Tank Steamers		28.25	33.77	24.12	24.12
Red Star Line		62.72—72.37	53.07—57.90	43.42—28.25	28.95
CANADA—					
Montreal		58.39—77.86	34.06—41.35		29.19—31.62
New Brunswick		30 00—35.00	20.00—25.00		
[3]Nova Scotia		25.00—45.00	20.00—30.00		30.00—35.00
CHILE—					
[4]Valparaiso		41.50	33.00	26.40	
DENMARK—					
Copenhagen		29.48	20.10		18.22
[5]FRANCE—					
Havre :					
French		57.90—67.55	38.60—48.25		17.37
British		29.20—38.93	24.33—29.20		19.47—24.33
German					
Italian		38.60	28.95		17.37
Scandinavian		20.10	16.08		17.42
Marseilles :					
French :					
Compagnie Générale Transatlantique	96.50	48.25			21.23
Compagnie des Messageries Maritime	96.50	38.60			14.47
Cyp. Fabre Compagnie	77.20	38.60			15.44
British		38.93—53.53	29.19—38.93		30.40
German		35.70	23.80	23.80	19.04
Scandinavian					12.15
GERMANY—					
Bremen					15.50—19.00
[6]Hamburg		29.75	21.42		17.34
Lower Baltic		23.80	17.85		19.04
[7]ITALY—					
Foreign Trade	70 00	40.00—50.00	40.00		16.00—18.00
JAPAN—					
Yokohama :					
Japanese		25.00—35.00	15.00—22.50		
American		50.00—90.00	40.00—60.00		40.00—45.00
British		58.40	48.67		
German		40.00—75.00	33.75—40.00		
NETHERLANDS—					
Amsterdam :					
East India Passenger		60.00—80.00	36.00—40.00	24.00—28.00	24.0
East India Freight		57.60	48.00	25.50—33.60	25.20
Holland America		40.00	28.00	16.00—20.00	24.00
[8]Tank Steamers		57.60	38.40	24.00	24.00
British		43.80	34.06	24.33	
Norwegian		50.92	40.20		
NEW ZEALAND—					
All Ports		68.13	58.40		48.66
UNITED KINGDOM—					
[9]Liverpool :					
British		55.61	40.83	33.52	31.50
French		48.25	48.25		15.44
German					
Scandinavian		19.46—34.06	14.59—24.33		21.89—26.76
Spanish		43.79	34.06		19.46
Southampton :					
American Line		120.00	70.00	70.00	
Royal Mail to South America		73.00—82.75	43.75—48.75	31.75—39.00	
Union Line to Cape		68.25—87.50	48.75—58.50	31.75—39.00	
[10]Glasgow :					
Allan, Anchor, and Donaldson Lines	97.33—121.66	60.82—72.99	48.66—60.82	36.49—48.66	

[1]Wages given are for coasting vessels. Few, if any, deep-water steamships are owned in the colony. [2]Seamen of nationalities other than those given are usually paid Austrian wages when hired. [3]These wages are paid in the foreign trade irrespective of nationality or ship. [4]Wages scheduled are in American gold equivalents. [5]French law requires that owners of vessels shall feed their men as well as those serving on war vessels—this figures out about 30 to 40 cents per day for each French merchant sailer. [6]Sailors must submit to a physical examination by government surgeons before being granted a permit to ship on German merchant vessels.

Turning now from the Atlantic to the Pacific, very similar conditions are found. The United States Consul at Yokohama reported the average wages paid on American, British, Japanese, and German ships at that port. By reference to the accompanying table the differences can easily be secured. Mates on American vessels receive a maximum of $90 a month, British $58.40; Japanese, $35, and German, $75. Again, Ameri-

SEAMEN OF VARIOUS RATINGS AND NATIONALITIES AT FOREIGN PORTS.

Boatswain.....	Quartermaster.....	Able Seaman.....	Chief Engineer.....	Second Engineer...	Third Engineer.....	Fourth Engineer....	Oilers.....	Firemen	Coal Trimmers.....
34.06	30.62	29.19	97.33—121.66	77.86—87.59	68.13—72.99	.....	38.93	38.93	29.49
17.03	14.00	12.16	58.38—77.84	34.06—48.65	19.46—29.19	.....	14.60	15.82	12.16
29.19	25.55	24.33	58.38—68.11	46.22	27.36	.....	25.00—26.00	26.76	24.00—25.00
19.04—21.42	19.04	11.90—16.66	59.50	28.56	23.80	.....	13.00—17.00	14.28—19.04	12.00—15.00
11.38—14.00	10.00—13.00	9.63	61.25	45.98	30.62	.....	12.00	12.25	11.38
.....	.....	17.37	77.20	57.90	43.42	36.19	.....	19.30	16.40—16.79
24.12	.....	19.30	77.20	57.90	43.42	33.77	23.16	21.62	16.40
28.95	.....	19.30	96.50—115.80	69.96—72.37	55.49—57.90	52.66—53.07	23.60	21.71	16 89
24.33—26.76	.....	19.46—21.89	82.73—102.19	63.26—82.73	43.79—58.39	.....	19.46—24.33	19.46—24.33	14.59—21.89
22.00—25.00	.....	18.00—20.00	75.00—100.00	60.00	45.00	.....	30.00	25.00—30.00	20.00
20.00—25.00	22.00—25.00	18.00—20.00	90.00—100.00	60.00—65.00	40.00—45.00	.....	28.00	25.00	20.00—22.00
16.50	11.50	10.00	82.50	49.50	33.00	.....	14.85	11.50	8.25
17.42	.....	16.08	53.60 93.80	32.16—53.60	26.80	.....	.....	16.08	16.08
23.16	.....	12.55	77.20—86.85	48.25—67.55	28.95—38.60	.....	19.30—23.16	15.44—19.30	11.58—13.51
17.03—21.90	19.47	14.60	77.86—97.33	48.67—73.00	34.06—38.93	.....	15.81—19.27	21.90—24.33	18.25—19.47
.....	.....	13.09	.....	.....	15.23	.....	.....	16.66	11.90
19.30	.....	12.55	77.20	48.25	.....	.....	9.65	19.30	10.62
17.42	.....	13.40	58.96	32.16	.....	.....	.....	14.74	13.40
24.12	.....	14.47	67.55	38.60	38.60	.....	.....	16.40—19.30	13.51
17.37	.....	14.47	57.90	28.95	.....	.....	.....	17.37—18.33	14.47
21.23	.....	13.51	77.20	38.60	28.95	.....	.....	16.40—21.23	.....
20.67	.....	15.80—17.02	63.26—68.13	48.66	31.62—38.93	.....	.....	17.02—18.24	14.59
17.85	.....	14.28—16.66	89.25	52.36	33.32	.....	.....	16.66	.....
13.89	.....	11.96	.....	.....	.....	.....	.....	13.51	8.68
.....	.....	10.71—11.90	65.00—101.19	43 00—71.90	25.00—47.62	.....	.....	11.90—14.28	11.55—14.55
15.71	17.85	13.33	59.50—71.40	35.70—42.84	23.80—33.82	.....	14.28—15.47	14.28—15.47	14.28—15.47
16.66	.....	13.09	42.84	23.80	20.23	.....	.....	13.09	.....
16.00—18.00	12.00	.....	70.00	50.00	30.00	30.00	18.00	16.00—17 00	12.00
9.00—10.00	7.00— 7.50	5.50	50.00—60.00	30.00—40.00	.....	.....	.....	5.50	.....
18.00—20.00	20.00—30.00	14.00—30.00	150.00	70.00—90.00	.....	.....	.....	14.00—20.00	.....
26.76	.....	14.60	.....	.....	.....	.....	.....	17.00—20.00	.....
15.50—18.75	14.75—13.00	14.25—15.00	62.50—100.00	53.75—62.50	.....	.....	.....	15.50—20.00	.....
22.00	15.20—16.00	12.00	80.00—120.00	54.00—68.00	36 00—40.00	24.00—28.00	16.00	15.20—16.00	10.00
23.20	15.20	14.00	86.40—96.00	52.00—62.40	28.00—40.00	24.00—28.00	.....	16.00	13.20
24.90	16.00	14 20	64.00—88.00	40.00—44.00	28.00	16.00	16.80	16 00	12.00
19.20	.....	14.40	96.00	57.60	48.00	28.80	.....	16.00	.....
24.33	.....	17.03	87.60	58.40	38.93	29.20	.....	18.24	.....
.....	.....	14.74	67.00	48.24	40.20	.....	.....	14.74	.....
36.50	31.63	31.63	97.33—121.66	77.86—87.60	58.40—70.56	.....	41.37	41.37	31.63
25.48	19.46	18.03	87.11	62.10	45.14	.....	.....	20.31	17 73
19.30	.....	11.58	77.20	48.25	33.77	.....	19.30	17.37	13.51
.....	.....	.....	48.66—72.99	36.48—48.66	29.19—36.48	.....	9.73 - 12.16	12.16—14.59	9.73—14.59
19.46—26.76	.....	14.59—17.14	58.39—97.33	38.93—58.39	29.19—43.79	.....	.....	14.59—15.80	13.38—14.59
19.46	.....	16.52	77.86	58.39	48.66	.....	18.48	13.62—17.51	.....
.....	.....	25.00	150.00	100.00	85.00	65.00	.....	40.00	30.00
.....	.....	19.50	121.75	77.75—87.50	58.50+	48.75+	.....	23.00	18.25—23.00
.....	.....	19.50	97.25—121.75	63.25—77.75	48.75—58.50	48.75	.....	23.00	18.25—23.00
24.33	23.11	19.46	87.59—116.79	58.39—87.95	38.93—58.39	.....	19.46	20 68—21.28	19.46

[7]U. S. Consul at Naples says: "Wages on Italian merchant vessels vary largely, there being no uniform rate. A separate and private bargain is made with each man, secrecy as to what is paid being enjoined." [8]These vessels vary in size from 1,734 to 4,157 gross tons. [9]Cunard and White Star Lines pay higher wages. [10]Regular lines in the East India trade employ Lascar seamen, who receive not more than $4 per month. Captains and deck officers are paid about the same rates as on the Atlantic, and engine and fire-room staffs receive 5% less. On ocean tramps wages are usually from 7½% to 10% less on all ratings as compared with regular lines.

can chief engineers receive $150 a month; Japanese, $60, and German, $100. American and European firemen get a maximum of $20, while the Japanese pay for the same work is $5.50 a month.

In addition to wages, the cost of maintenance is, of course, a considerable part of the expenses of operation, especially on long voyages. Unfortunately, none of the queries addressed to United States Consuls by the Department of State covered this point, so that the information on the subject in the published reports is confined to a very few statements, made voluntarily. The United States Consul at Havre, France, as the result of an unofficial investigation at that port, reports the cost of maintenance for each man to be as follows: Norwegian and Swedish vessels, 25 cents a day; German vessels, 36 cents; English vessels, 25 to 35 cents; Italian vessels, 22 cents, and French merchant vessels, from 30 to 40 cents a day. At Marseilles, France, the United States Consul made inquiries among the consular officers of other nations, and as a result reports average allowances as follows: For British officers $1.21 and crew 36 cents a day; Italian officers 30 cents and crew 19 cents; Norwegian and Swedish officers and crew 41 cents; Austria-Hungary, for officers 38 cents and crew 30 cents a day.

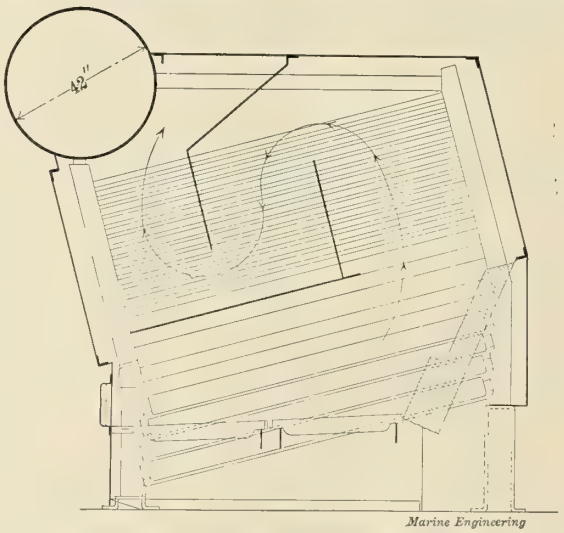
Many who have not studied the question have an opinion that it is only in this country that the merchant marine is the subject of discussion and agitation, and that there is something novel about the proposition of government aid as well as control. For those who seek information which will quickly dispel such ideas a perusal of the publication here quoted from is recommended. Not only are those maritime nations which are lacking in proper shipping facilities widely awake to the need for energetic action, but even the British are alive to the importance of maintaining their position on the seas. Causes such as operate to keep our flag off the seas—so long as Congress is content to let it remain on land—are recognized as being, in many instances, detrimental to British interests, and if so to theirs, how much more so to ours?

Wreck of S. S. Carinthia.—One of the Cunard Line freight steamships, the *Carinthia*, on the Boston route, was recently chartered by the British Government to take 1,450 mules from New Orleans to Cape Town, and while on the voyage out went ashore at Point Gravois, Haiti, May 15. A steamer which went to her assistance reports that the *Carinthia* is fast ashore, and her forehold is full of water. Many of the mules were landed in safety, but several hundred are reported to have been lost. A wrecking steamer has been ordered to the scene. This vessel, and her sister ship, the *Sylvania*, came out about 1895, and attracted much attention on account of their economical performances. The dimensions of the *Carinthia* are: Length, 460 ft.; beam, 49 ft.; depth, 42 ft. 6 in.; dead weight capacity, 7,500 tons; displacement, 12,160 tons. She is fitted with twin screw main engines of about 5,000 I. H. P., with cylinder 22 1-2 in., 36 1-2 in. and 60 in. dia., and 48 in. stroke. The boilers are of the Scotch type, worked with Howden draft. The sea speed is about 15 knots. The mishap is reported to have been caused by an error in the chart.

PROTECTED CRUISERS OF THE DENVER CLASS FOR THE U. S. NAVY.

Unlike merchant vessels, designs for warships have always been regarded as tentative, governed by a judicious compromise of weights allotted to the following: Hull proper; machinery, which gives speed; armor, armament and ammunition; coal carrying capacity, or endurance to keep the sea. Naval experts have, at all times, differed as to the relative importance of these, both for cruisers and battleships; moreover, the problem changes from time to time to conform to the progressive improvements in materials. It happens, therefore, that a wise distribution of weights for any class of war vessels to-day may not be so regarded a few years hence.

In contracting for six vessels of the *Denver* class, the Navy Department has made a marked departure from recent practice in one notable particular—speed—the machinery weights apportioned being only sufficient to provide a maximum speed of 16 1-2 knots at full power.



B. & W. BOILER SHOWING PATH OF GASES (SEE PAGE 246).

An important feature of design centers in the liberal coal bunker capacity allotted—700 tons when fully stowed—and the consequent extended steaming radius at economical speed. At about 10 knots these vessels will be able to cover about 6,300 knots without recoaling, and in the neighborhood of 2,300 knots at full power.

Another unusual characteristic, not heretofore embodied in warship designs in this country to any extent, consists in wood-sheathing and coppering the steel outside plating to slightly above the load water line. Although this involves considerable extra weight, the immunity of the coppered bottom from a tendency to foul, compared with steel, furnishes a substantial reason for the adoption of the proposed plan in the consequent maintenance of speed and saving of fuel, in addition to decreased cost due to frequent docking. The wood-sheathing is to be of Georgia pine, fitted in a single thickness of 4 in., and secured to the plating by composition bolts.

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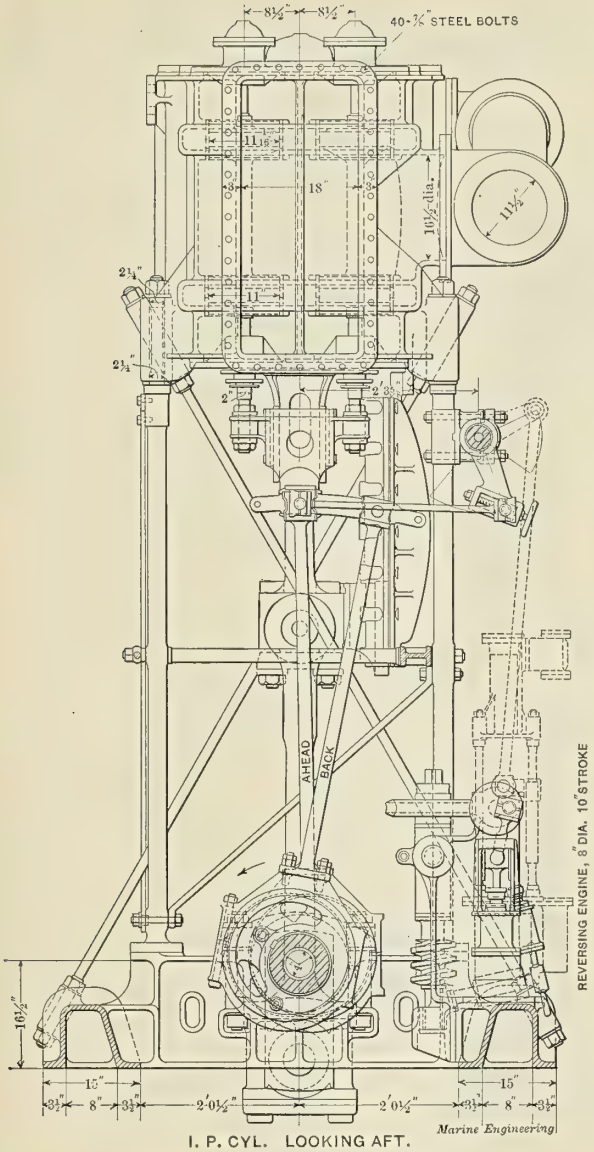
[1]See Marine Engineering, Vol. IV, pages 1 and 260, and Vol V, page 157.



I. P. CYL. LOOKING AFT.

SCALE OF FEET

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END ELEVATION MAIN ENGINES—DENVER CLASS.

In previous issues[1] we have presented an account of the principal characteristics of these cruisers and also a concise report of the contents of a paper by Chief Constructor Philip Hichborn, U. S. N., on the designs of the *Denver* class, read at the 1899 meeting of the Society of Naval Architects and Marine Engineers, together with the discussion evoked. We now supplement this with technical details of the construction of the hull and machinery, together with drawings to scale:

Length over all	308.75 ft
Length on load water-line	292 "
Beam, moulded	43 ft 3¼ in.
Beam, extreme	44 ft.
Area of midship section	615.2 sq. ft.
" " load water plane	9,370 " "
Mean draft (with 467 tons of coal and ⅔ stores)	15 ft 9 in.
Corresponding (trial) displacement	13,200 tons.

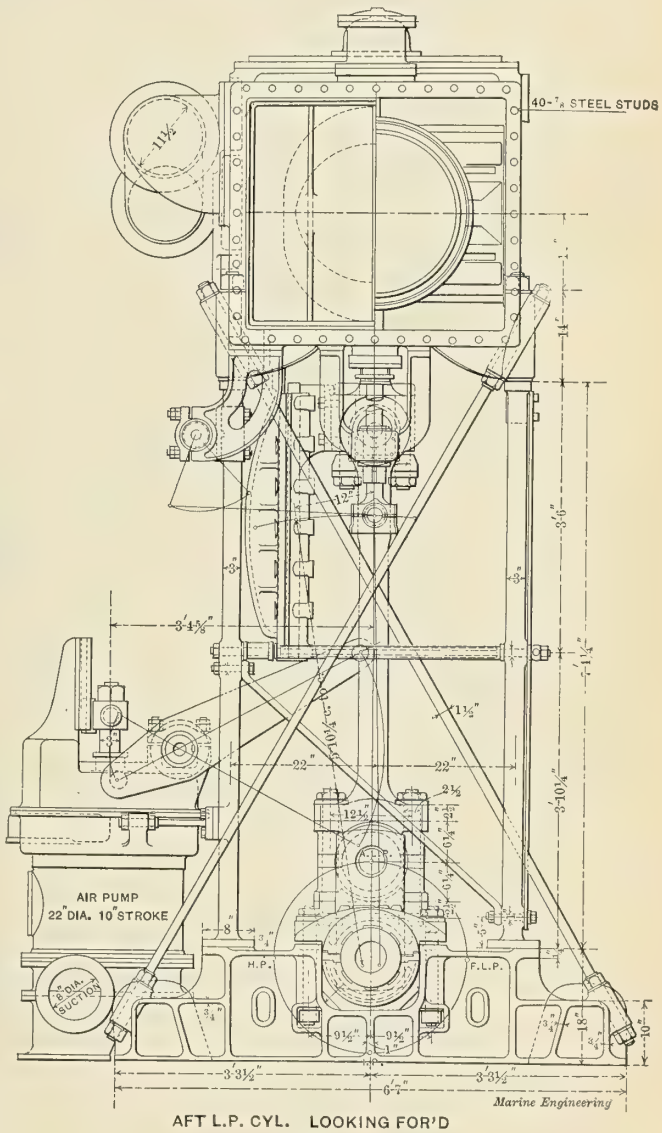
GENERAL DESCRIPTION OF THE HULL.

The stem is made in two pieces, the lower part of cast manganese bronze and the upper of rolled bar iron 9 in. by 4 in.; the stern post is of manganese bronze. Frames are spaced 36 in. from center to center, and composed of steel Z-bars, 6 in. by 3 1-4 in. by 3 1-2 in., weighing 15.6 lb. per running ft.

The outside plating is generally of 15 lb. plate (3-8 in. thick) per sq. ft., as are also the inner flat and vertical keel plates; the outer flat keel is of 20 lb. plate.

Three longitudinals are worked on each side of the vertical 34 in. keel; the first and second are of 12 1-2 lb. plates, and extend about 190 ft. in length of the vessel; the remaining longitudinal, which forms the outer marginal plate on each side of the double bottom, is about 135 ft. in length and composed of 15 lb. plate.

Three complete steel decks are fitted, the beams being of angle bulb section, 7 in. by 3 in., of 18 1-4 lb. per lineal ft., and the deck plates varying in weight between 10 and 20 lb. per sq. ft. The protective deck is 1-2 in. thick throughout, and in addition 2 in. of nickel steel plate, 8 ft. in width, is fitted on each slope for a length



AFT L.P. CYL. LOOKING FOR'D

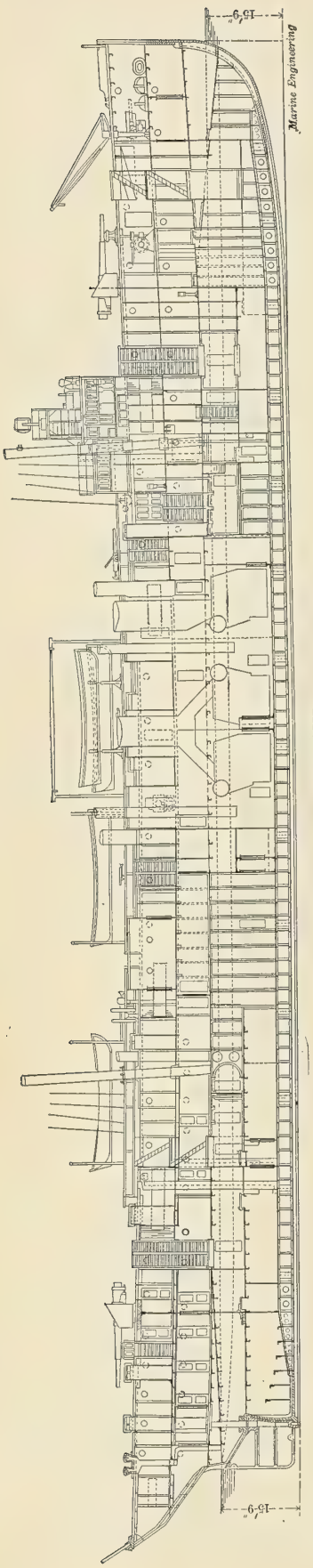
SCALE OF FEET

0 1 2 3 4 5

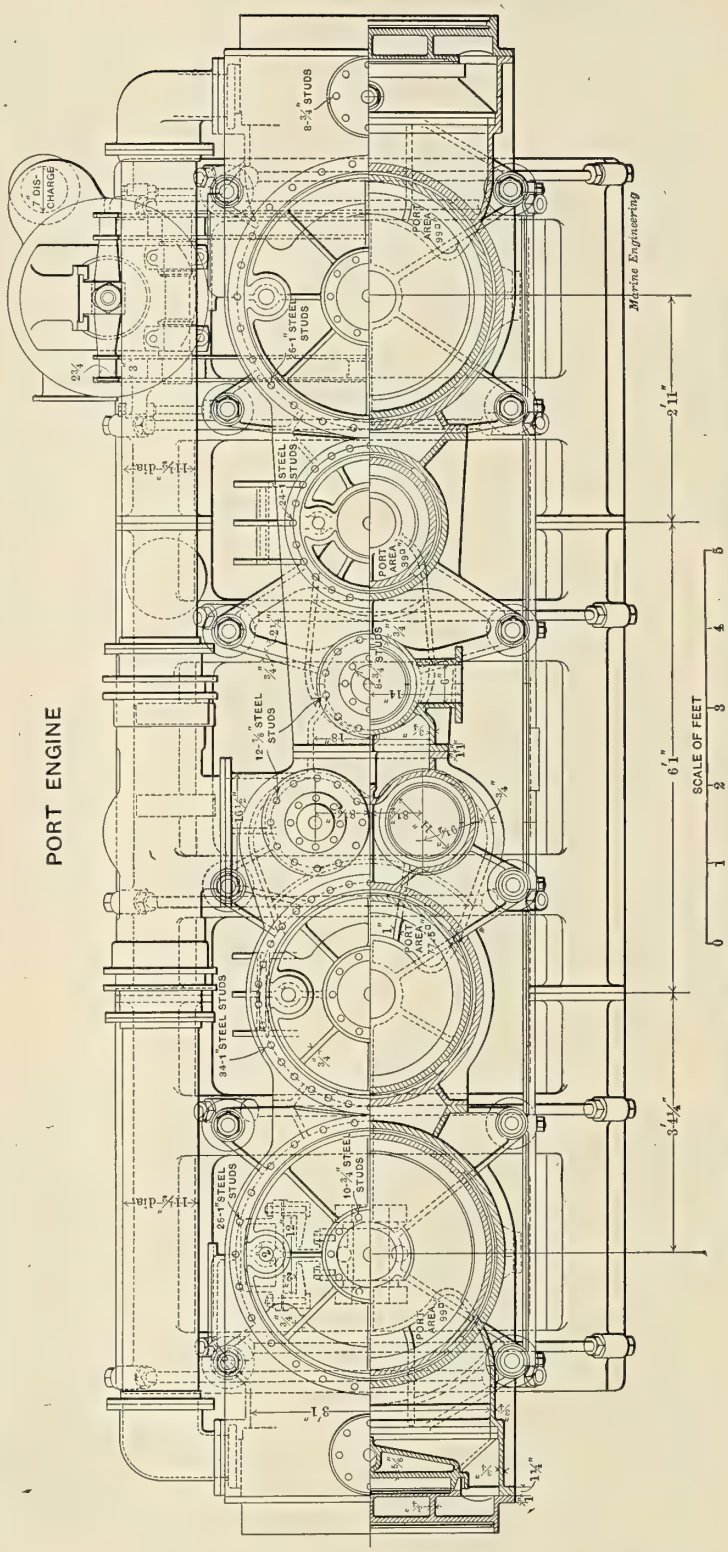
END ELEVATION MAIN ENGINES—DENVER CLASS.

of 105 ft. in the wake of the machinery; forward and abaft of this the 1-2 in. plating is of double thickness.

Only the main deck is planked with wood, and this, together with all other wood used in the construction of the vessel, except outside sheathing and that used for special purposes, is to be fireproof before being worked



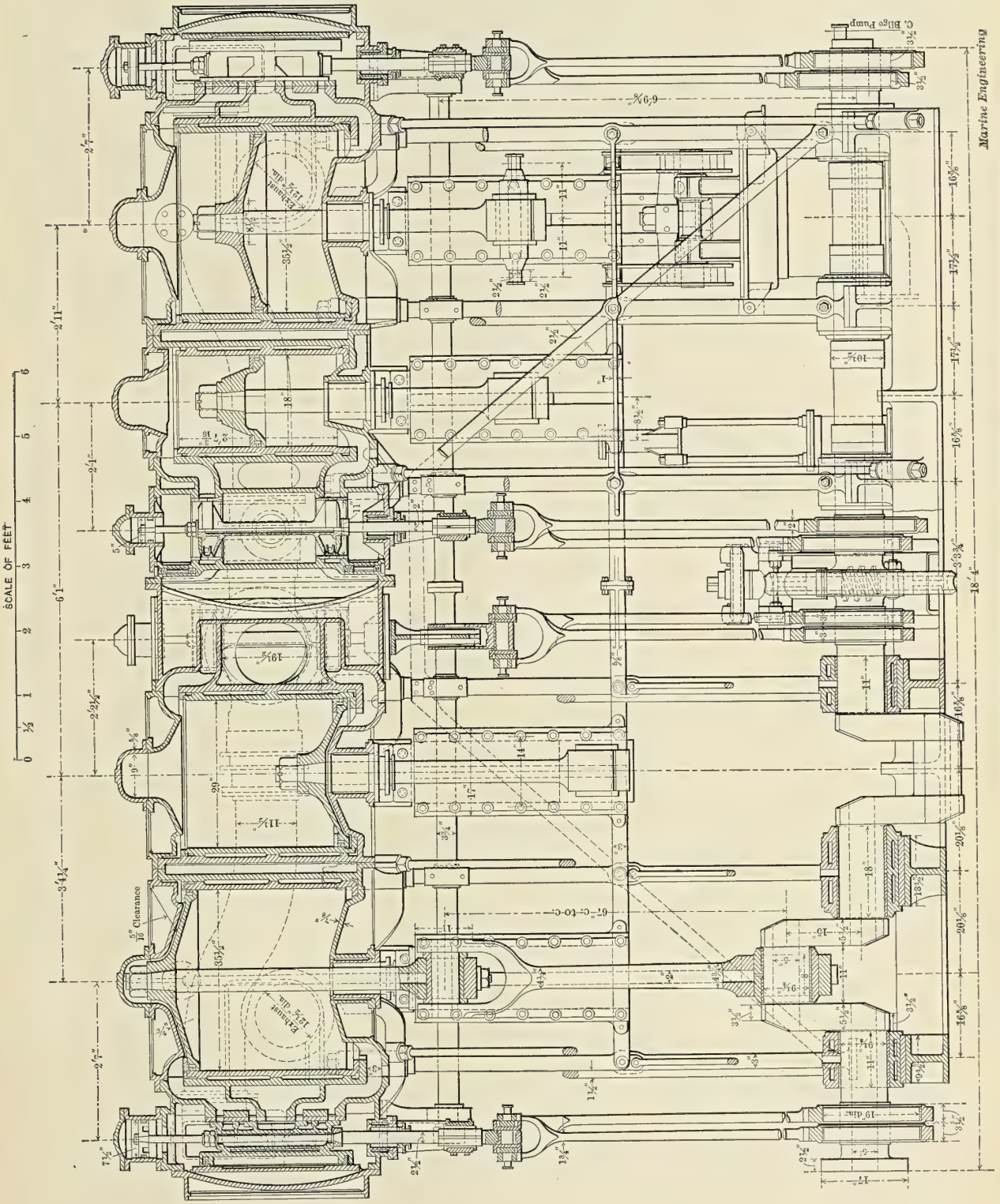
INBOARD PROFILE OF DENVER CLASS OF TWIN SCREW, SHEATHED, PROTECTED CRUISERS NOW BUILDING FOR THE U. S NAVY—DESIGNED BY NAVAL BUREAU OF CONSTRUCTION AND REPAIR.



PLAN VIEW OF TRIPLE EXPANSION MAIN ENGINES OF U. S. DENVER CLASS OF PROTECTED CRUISERS.

into the vessel. The use of wood is reduced to a minimum, corrugated metal being substituted where feasible.

Immediately above the protective deck, and extending

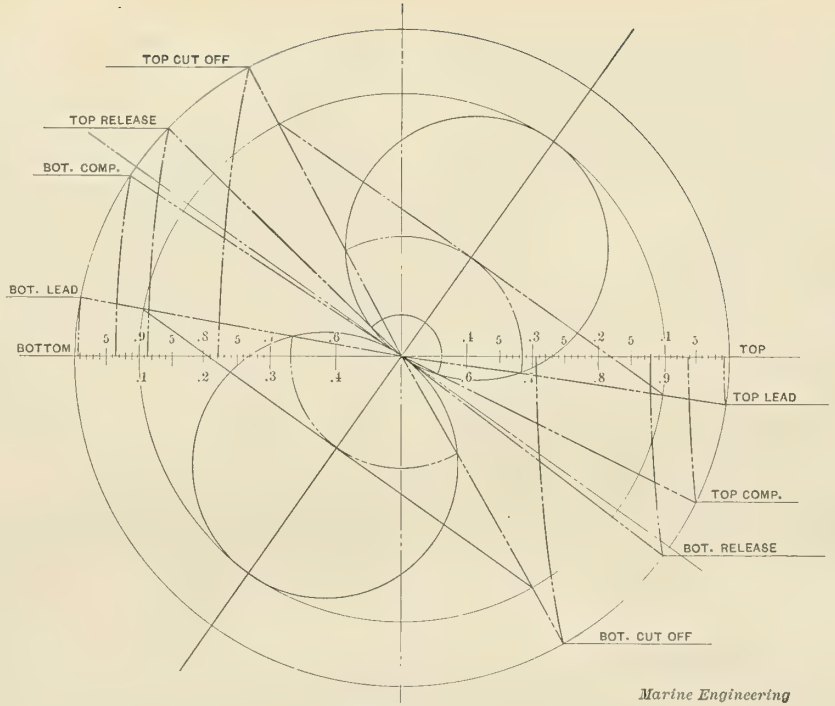


SECTIONAL ELEVATION OF TRIPLE EXPANSION MAIN ENGINES OF DENVER CLASS OF PROTECTED CRUISERS—DESIGNED BY U. S. NAVAL BUREAU OF STEAM ENGINEERING.

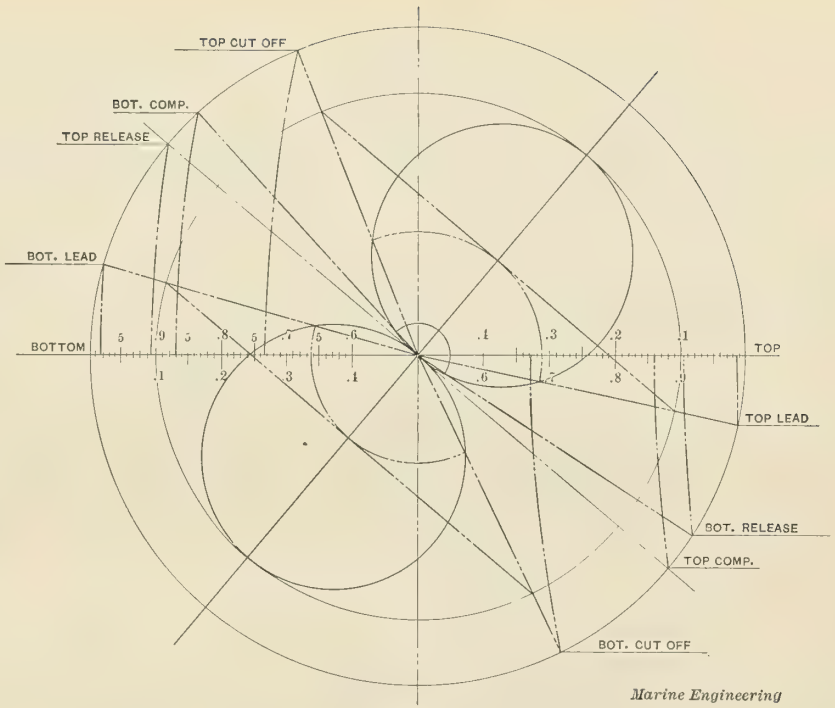
above and below the normal water line, a cofferdam, 4 ft. in height and 27 in. in width, is provided. This is to be filled with fire-proof corn pith compressed cellulose to prevent the ingress of water in case of a chance shot through the outside plating.

ARMAMENT.

The main battery consists of ten 5-in. rapid fire guns, 50 calibres in length. One of these is to be mounted forward and another aft on the amidship line on the



H. P. & I. P.



L. P.

VALVE DIAGRAMS FOR TRIPLE EXPANSION MAIN ENGINES OF DENVER CLASS OF PROTECTED CRUISERS, DRAWN BY THE NAVAL BUREAU OF STEAM ENGINEERING.

main deck, and four on each side of the gun deck below. The secondary battery consists of the following: Eight 6-pound rapid fire guns; two 1-pounders; four machine guns, and one field gun. A full allowance of ammunition, for which provision is made in the magazines, weighs about 343,000 lb.

MACHINERY.

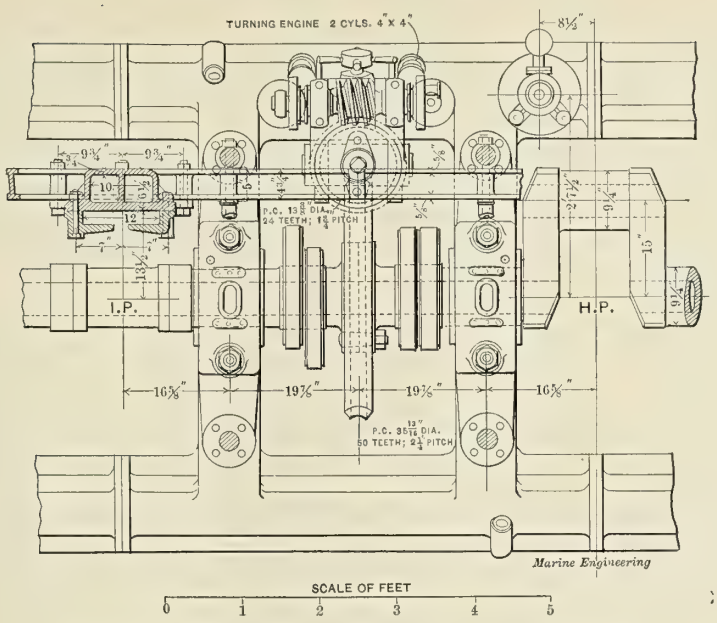
Designs for the machinery were prepared in the Bureau of Steam Engineering, Navy Department, under the supervision of Engineer-in-Chief George W. Melville.

The propelling engines, which drive twin screws, are placed in water-tight compartments, separated by a middle-line bulkhead. Each is of the vertical, inverted-cylinder, direct-acting triple expansion type, with a high pressure cylinder of 18 in., intermediate of 29 in., and two low pressure cylinders of 35 1-2 in. dia. The stroke of all pistons is 30 in., and the collective indicated horse-power of the main propelling and circulating-pump engines is calculated to be 4,500 when developing full power. Under these circumstances the main engines are expected to make about 172 revolutions per minute with a steam pressure in the boilers of 275 lb. reduced to 250 lb. at the high pressure cylinders.

Beginning forward, the arrangement of cylinders is: forward low pressure, high pressure, intermediate, and after low pressure. The cranks of the forward low pressure and high pressure are opposite, as are also the cranks of the intermediate and after low pressure.

All main valves are worked by Stephenson double-bar links, the various parts of which for the four cylinders, so far as practical, are made interchangeable. Each high pressure cylinder is provided with one, and each intermediate cylinder with two piston valves, all of the same dimensions; double ported balance slide valves are fitted to the low pressure cylinders, and all main valves are provided with a balance auxiliary piston.

The reversing gear for each engine consists of a steam cylinder and a hydraulic controlling cylinder, acting directly on two arms fixed to the reversing



DETAILS OF CROSS HEAD SLIDES, CRANKS AND TURNING GEAR.

shaft. By a system of differential levers motion of the steam engine reversing valve—primarily derived from the hand lever on the working platform—causes the reversing engine to follow, or to come to rest, accordingly as the hand lever is moved or stopped.

The framing for each engine consists of six front and

Name of Vessel.	Cruisers Nos. 14 to 19. "Denver" Class.					
Total I.H.P. and Displacement.	4500 I.H.P 3200 Tons Displacement.					
Type and number of Engines.	4 Cyl. Vertical Inverted Triple Engine Twin Screw.					
Diams. of Cylinders and Stroke.	18", 29", 35⅛", 35½" x 30" Stroke.					
Valve Gear.	Stephenson Link.					
Connecting Rod.	67" between centers.					
Scale of Crank Circle 4"=1 Ft.	Scale of Valve Circles 24"=1 Ft.					
	H.P.		I.P.		L.P.	
Eccentricity.	2"		2"		2"	
Travel of Valve.	4"		4"		4"	
Kind and No. Valves and Diam. if Piston Valves.	One Piston 11" Dia.		Two Piston 11" Dia.		One Double Ported slide	
Side of Valve on which Steam is taken.	Inside.		Outside.		Outside.	
	Top	Bottom	Top	Bottom	Top	Bottom
Width of Port and Length if Slide Valve.	1½	1½	1½	1½	1½ x 37	1½ x 37
Steam Lap.	29/32	27/32	29/32	27/32	15/16	13/16
Exhaust Lap.	−5/16	−1/16	−5/16	−1/16	0	+¼
Angular advance.	35°	35°	35°	35°	40°	40°
Steam Lead. Angular.	8°	10°	8°	10°	12°	16°
Steam Lead. Linear.	¼	5/16	¼	5/16	11/32	15/32
Cut off in inches.	23⅜	21 3/16	23⅜	21 3/16	22 1/16	20 3/16
Cut off in decimal of stroke.	.78	.705	.78	.705	.735	.672
Exhaust Release in inches.	3 7/16	3⅝	3 7/16	3⅝	2 13/16	2⅞
Exhaust Release in decimal.	.114	.1205	.114	.1205	.093	.095
Compression in inches.	1⅞	1 15/16	1⅞	1 15/16	4 3/16	3⅞
Compression in decimal of stroke.	.062	.064	.062	.064	.139	.129
Steam opening.	1 3/32	1 5/32	1 3/32	1 5/32	1 1/16 x 2	1 3/16 x 2
Exhaust opening.	Full Port		Full Port		Full Port	
Velocity of Steam in ft. p. sec. @ 860 ft. per. min. 172 Revs. per. min.	128.6	121.6	166.9	157.9	189.3	169.4
Velocity of Exhaust in ft.p. sec. @ 860 ft. per. min. 172 Revs. per. min.	93.82	93.82	121.7	121.7	134.12	134.12
Velocity of Exhaust to Condenser.	115.6 ft. per sec. 12½" Nozzle.					

DATA TO ACCOMPANY VALVE DIAGRAMS ON OPPOSITE PAGE.

six back forged steel columns, 3 in. dia., trussed by forged steel stays, and the bed plates are of cast steel, supported on the keelson plates.

All shafting is hollow, and forged from nickel steel, made by the open hearth process; piston and connecting rods, and working parts generally, are also of the same material. Tensile specimens of shafting must have at least an ultimate strength of 80,000 lb. per sq. in. of section, and an elongation of 25 per cent in 2 in. Forgings for piston and connecting rods must show a tensile strength of 95,000 lb. and an elongation of 21 per cent in 2 in.

Each main engine is provided with a cylindrical condenser 4 ft. 4 1-2 in. inside dia., and 11 ft. long over all. The shell is 1-4 in. plate steel, and the water chest at each end is of cast composition 1-2 in. thick. In each condenser there are 2,004 seamless drawn tubes 5-8 in. outside diameter, No. 18 B. W. G. thick, 9 ft. 2 in. long between tube sheets, and which provide 3,000 ft. of cooling surface measured on the outside of the tubes.

There is, for each engine, one vertical single-acting air pump, worked by link and beam connections from the forward low pressure crosshead. The pump cylinder is 22 in. dia., with a stroke of 10 in.

A centrifugal circulating pump, driven by a two cylinder engine is installed for each condenser. These pumps are of the double-inlet pattern and so arranged by valves to draw either from overboard or the bilge; when connected to the latter, each pump is capable of discharging 5,000 gal. of water per min., running at a speed not to exceed 300 revolutions.

The screw propellers are entirely of manganese bronze, with blades cast separately and bolted to a boss. Before being fitted to its shaft, each propeller is to be accurately balanced, tinned all over and burnished. The starboard propeller is left and the port right handed.

The usual auxiliary machinery, common to all war vessels, is to be installed. In addition to the various pumps, steering and anchor engines, blowers, etc., provision is made for electric lighting, ice, and distilling plants. The exhaust steam from these is utilized as an agent to elevate the feed water temperature by means of a heater placed in each engine room.

Steam is to be supplied by six boilers of the water tube type, located in two water-tight compartments forward of the engine rooms. The working pressure is 275 lb. per sq. in., and the minimum total grate and heating surface for all boilers is 300 and 13,000 sq. ft. respectively. Two boilers are placed in the after and four in the forward compartment, with a smoke pipe 70 ft. in height above the grates for each nest of boilers. The clear cross sectional area of each smoke pipe is one-seventh the grate area of the boilers, to which it connects. One athwartship fireroom is provided for the boilers in each compartment.

The type of boiler selected for three of the vessels of this class—the *Chattanooga, Galveston,* and *Tacoma*—is the well known Babcock & Wilcox design, a description of which appeared in our issue for March last. Boilers for these vessels differ in some slight particulars from that described, but principally in the method adopted of directing the flow of the gases of combustion, which is done by means of baffles, as indicated by arrows in the accompanying engraving. (See page 240.)

A summary of the trial displacement weights is as follows:

SCHEDULE OF WEIGHTS.

Hull and fittings, not including protective deck armor	1,706	tons.
Protective deck armor, 2 in.	62	"
Cellulose	24	"
Armament and ammunition	213	"
Equipment, stores, and outfit	287	"
Propelling machinery with water	441	"
Coal	467	"
Total	3,200	"

The successful bidders and contract price for each ship is shown in the table which follows:

Name of Vessel.	Contractors.	Location of Works.	Contract Price.
Denver	Neafie & Levy Ship & Engine Building Co.	Philadelphia, Pa.	$1,080,000
Des Moines	Fore River Engine Co.	Weymouth, Mass.	1,065,000
Chattanooga	Lewis Nixon.	Elizabethport, N. J.	1,039,966
Galveston	Wm. R. Trigg Co.	Richmond, Va.	1,027,000
Tacoma	Union Iron Works.	San Francisco, Cal.	1,041,900
Cleveland	Bath Iron Works.	Bath, Me.	1,041,650

According to the terms of the contract, all these vessels are to be ready for delivery to the Government on or before June 14, 1902.

Relief Ship for India's Starving.

In this land of plenty it is practically impossible to realize what the word "famine" means. It is at present understood, however, in all its horrible reality by millions of starving inhabitants of British India. To aid in the alleviation of this suffering, persons of all denominations in the United States and Canada, who are readers of the *Christian Herald,* have contributed 200,000 bushels of corn, which are now en-route to Bombay on the S. S. *Quito.*

When the corn had been collected application was made to the United States Government for the services of a vessel to carry it from the port of New York to India. Under the provisions of an existing law authority was given to charter a vessel for the purpose. Lieutenant-Commander Nickels, U. S. N., was directed to select a suitable vessel, and his choice fell on the S. S. *Quito.* It is a sad commentary on the condition of our merchant marine that the vessel sent on this errand of mercy flies a foreign flag. She was undoubtedly the most suitable vessel to be had, and being a comparatively new and a staunch ship, she is expected to arrive out about June 20, with her cargo in prime condition.

The work of loading the vessel was commenced at the Brooklyn, N. Y., water front on Monday, May 7. The cargo was delivered to the vessel by floating elevators, in bulk, and was sacked before being stowed. A snapshot on the deck of the *Quito* when loading is here reproduced. By the following Wednesday evening the vessel was loaded and ready for sea, and she sailed May 10. Special religious services were held on board before her departure. On the trip out brief stops will be made at the Azores, Port Said and Aden, for coal.

Dr. Louis Klopsch and the Rev. E. S. Hume are the consignees, and they have already reached Bombay and arranged for the unloading and distribution of the

RELIEF STEAMER S. S. QUITO AT WHARF—PHOTO BY COURTESY OF AND COPYRIGHT, 1900, BY BROOKLYN EAGLE.

corn. In the latter work they will be assisted by an Interdenominational Missionary Committee, which is composed of American missionaries, with Dr. Robinson, of the Methodist Church at Calcutta, as chairman.

It is authoritatively stated that this is the largest cargo ever carried by any vessel on a like errand. The

SACKING GRAIN FROM ELEVATOR SPOUTS ON DECK OF S. S. QUITO, AT BROOKLYN, N. Y.

200,000 bushels of choice two-year-old corn are valued at over $100,000, and at the famine prices in India are worth not less than $300,000. The charter price paid by the United States Government was $40,000.

The S. S. *Quito*, Captain Baird, was built last year at Port Glasgow and flies the British flag. Her dimensions are: Length, 330 ft.; beam, 45 ft. 6 in.; depth, 26 ft. 6 in.; gross tonnage, 3,200 tons. She is fitted with triple expansion engines, built by Dunsmuir & Jackson, Glasgow, with cylinders 24 in., 40 in., and 65 in. by 43 in. stroke. She is classed 100 A1 at Lloyd's.

A SIMPLE EXPLANATION OF THE CONSTRUCTION AND USES OF THE PLANIMETER.—III.

BY CECIL H. PEABODY.

The Coffin averaging instrument shown by Fig. 14 is a planimeter which has one end of the tracing-arm guided by a straight groove, and which has its measuring-wheel set to one side, with its axis parallel to the tracing-arm. A movement of the tracing-arm parallel to itself will describe a parallelogram like Fig. 7, and its area will be properly measured by the wheel; the instrument is always used in the first method (as in measuring indicator diagrams); consequently the effect of

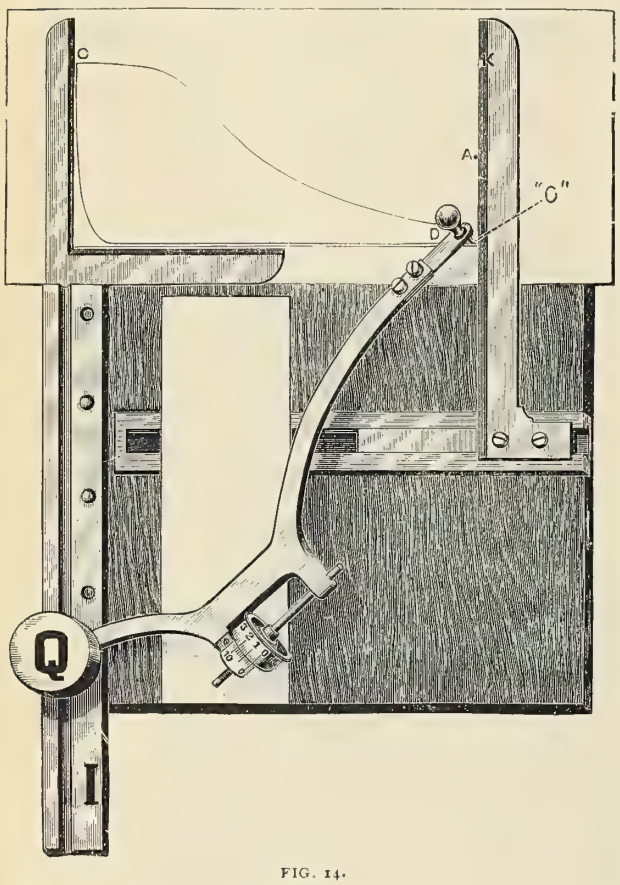


FIG. 14.

the swinging of the arm back and forth is finally zero, whether the axis of the wheel coincides with the arm or is parallel to it. The arm is 6 in. long, and the wheel has a circumference of 2 1-2 in., consequently one turn of the wheel is equivalent to 15 sq. in.; the scale of the wheel is divided into 15 parts, each of which corresponds to 1 sq. in. of area; these parts are each divided into five subdivisions, and a vernier allows us to read to a tenth of a subdivision.

The instrument is designed to give the mean effective pressure of an indicator diagram directly. For this

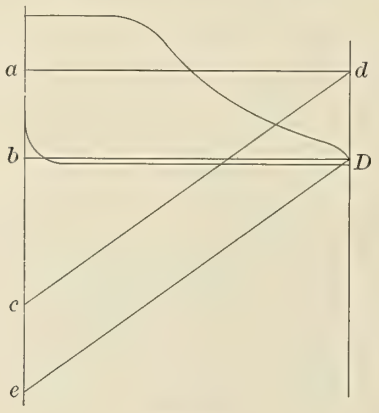


FIG. 15.

purpose the diagram is placed under a fixed clip with a vertical and a horizontal arm; in the figure the atmospheric line is brought to the edge of the horizontal arm, but if the engine has a vacuum it will be convenient to use a parallel line entirely below the diagram, such as the line of zero pressure. A movable clip is brought to the right-hand end of the diagram. A point at the right-hand end in contact with the clip, such as *D*, is chosen as the starting-point for measuring the diagram, which is traced toward the right in the usual way. Suppose that the wheel is set at zero before the figure is traced; then after the tracing-point has returned to *D* the reading of the wheel will give the arm of the diagram in square inches. If this area is divided by the length of the diagram, the quotient will be the mean height of the diagram, which may be set up at *Dd*, Fig. 15, and the equivalent rectangle *adDb* may be drawn. This rectangle is equal in area to the parallelogram *cdDe*, consequently if the tracing-arm is raised par-

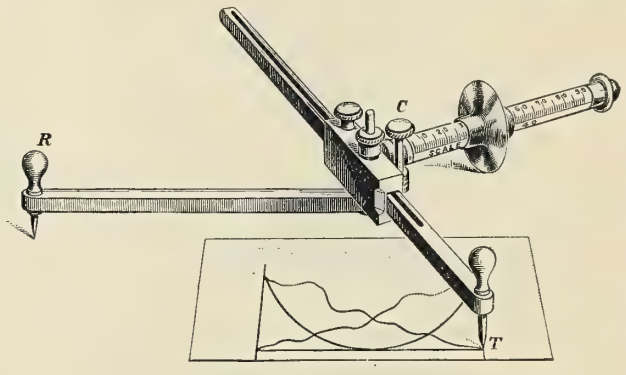


FIG. 16.

allel to itself with the tracing point against the clip till the wheel returns to zero, the tracing point will come to *d;* the distance *Dd* is the mean width of the diagram, and may be measured with the proper scale.

Fig. 16 represents Lippincott's planimeter, which,

like the Amsler planimeter, has a tracing-arm and a guiding-arm, but the wheel is on a perpendicular branch of the tracing-arm, as shown in the figure. This branch is a glass tube, which has a paper scale inside. The wheel is free to slide on the glass tube, but it has a sharp edge and cannot slide on the paper. An improved form of this instrument, known as the Willis planimeter, is shown by Fig. 17. The wheel W is carried by a rod, which passes under rollers at R and S, and moves over a scale MN which can be changed to correspond to the scale of the spring. If the tracing-arm is taken separately and moved over the rectangle $hpqi$, Fig. 18, the tube cd will draw through the wheel w, a distance equal to the width of the rectangle, or we may say that the wheel slides that distance on the arm. If the tracing-arm is 4 in. long and the area of the diagram is 10 sq. in., the wheel will slide 2 1-2 in.; one-tenth of this or 1-40th of an inch will consequently correspond to one square inch of area. If the tracing-arm is moved parallel to itself while the hinge h remains on the curve hi, Fig. 19, the wheel will roll from w to w'', and will slide a distance equal to the height of the figure; the length of the arm multiplied by the distance w' w'' is equal to the area of the figure.

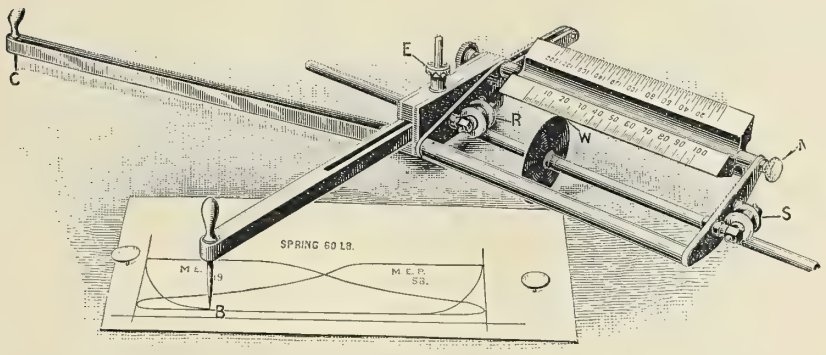


FIG. 17.

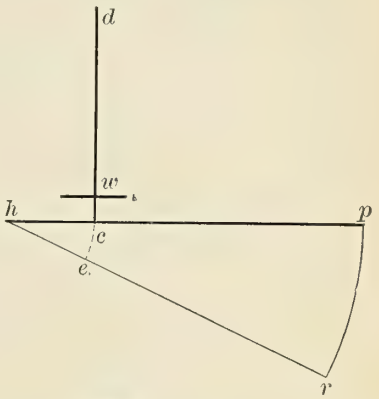


FIG. 20.

If the arm hp is pivoted about a point as in Fig. 20 the arm cd at any instant will have two motions: (1) it will be drawn endwise through the wheel, and (2) it will swing around just as fast as the arm hp does; the first action affects the reading on the scale, and the second, which makes the wheel roll, does not. A little consideration will make it appear that the tube cd is drawn endwise a distance equal to the arc ce, as the arm hp swings to hr; and also that the distance the wheel slides on the tube cd does not depend on its position on the tube; it is true that the wheel rolls further when it is more remote from c, but that does not affect the reading.

We are now ready to consider a diagram $pqrs$, Fig. 9. As with Amsler's planimeter, there are four operations to consider: (1) the arm hp moves parallel to itself and the wheel measures the area $hpqi$; (2) the arm hp swings through the angle qir, and the wheel records the distance fg; (3) the arm moves parallel to itself and the wheel measures the area $rihs$; and (4) the arm swings through the angle shp, and the wheel records the distance ec. But ec is equal to fg, and is recorded in the contrary sense, and therefore the pivoting about i and about h have finally no influence on the reading. The instrument records finally the difference between the area $hpqi$ and $hsri$ because the latter is measured in contrary direction, or is subtracted, which gives the area of the figure $pqsr$. The extension of the action of the instrument from a figure like $pqsr$ to an irregular diagram is of course just like that given for the Amsler planimeter. This instrument, like the Amsler planimeter, could be used to measure large figures with the pivot inside the contour as in Figs. 12 and 13, if the tube cd were long enough, the discussion for establishing this proposition being almost identical with that given for Fig. 12; but as the tube is not long enough the instrument cannot be so used.

This instrument is commonly used to give the mean effective pressure of indicator diagram, much as the planimeter shown by Fig. 3 can be used. The tracing-arm is made equal to the length of an indicator diagram, and consequently the reading of the planimeter is equal to the mean width of the diagram in inches, or in pounds per square inch, depending on the gradation of the pa-

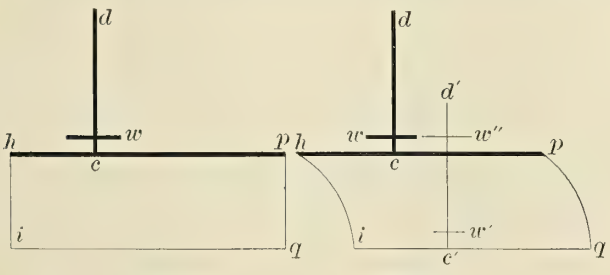


FIG. 18.

FIG. 19.

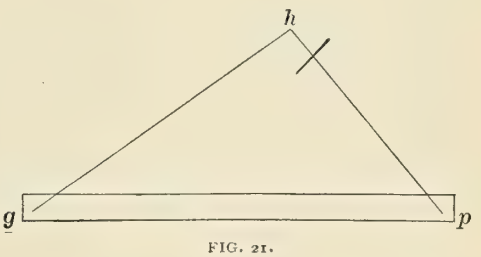


FIG. 21.

per scale inside the glass tube. Several tubes, with two scales each, are furnished with the instrument. A scale of inches and tenths can be used for measuring the width of a diagram in inches, or it may be used as a 10 scale or a 100 scale for reading mean effective pressures directly; other scales are conveniently arranged for various indicator springs.

Through the hinge of this instrument there is a style that is retracted by a spring, but it can be thrust down even with the tracing-point by pressing on its head. With this point pressed down the length of the tracing-arm can be conveniently made equal to the length of the diagram, when it is desired to determine the mean effective pressure of an indicator diagram. If the area of a diagram is desired the length of the tracing-arm can be set by direct comparison with a scale of inches; for example, the arm may be made four inches long and a scale of 40ths may be used for measuring area in square inches, ten 40ths corresponding to one square inch; or the arm may be made 5 in. long with a scale of 50ths in the glass tube.

It is claimed for the Lippincott and Willis planimeters that as the rolling of the wheel does not affect the reading, the wheel will not be spoiled by slight injuries to its edge. This might be true if the wheel rolled on a straight line as in Fig. 18, but lack of truth of the wheel will have some effect when the arm swings, as it will change the path on which the wheel rolls. It may be that slight injuries will have less injurious effect than with the wheel of the Amsler planimeter, but a planimeter that is properly handled and kept is not liable to suffer injury.

The truth and accuracy of any planimeter can be tested by tracing a figure of known area provided means be taken to make the tracing-point follow the outline exactly. Amsler's planimeter can be tested by using a slip of paper as a bridle to keep the tracing-point *p* at a constant distance from the pivot *g*, and thus tracing a circle with *g* at its center, as in Fig. 21.

NEW 750 FT. LINER.—Following closely upon the construction of the Hamburg-American liner *Deutschland*, with an estimated rate of speed of 23 knots, comes an order from the North German Lloyd Line to the same builders—Vulcan Works at Stettin—for a larger and swifter vessel for the transatlantic trade. A few particulars of this new vessel given out show that in dimensions, power and speed she will far outclass any vessel previously constructed. It is stated that she will be about 750 ft. in length and will be propelled by engines of not less than 45,000 I. H. P., which will give her a sea speed considerably greater than the *Deutschland*. Rivalry between these two great German steamship corporations is intense, and may result in still further developments in the future, unless they follow the example of the British Union and Castle lines, and consolidate. The contest for supremacy between these two lines must be immensely to the satisfaction of the Emperor of Germany, who sees in every new fast liner an important addition to the Imperial fleets in time of war.

It has been decided to change the name of the American liner *Paris* to *Philadelphia* when she comes out again after reconstruction at the yard of Harland & Wolff, Belfast, Ireland.

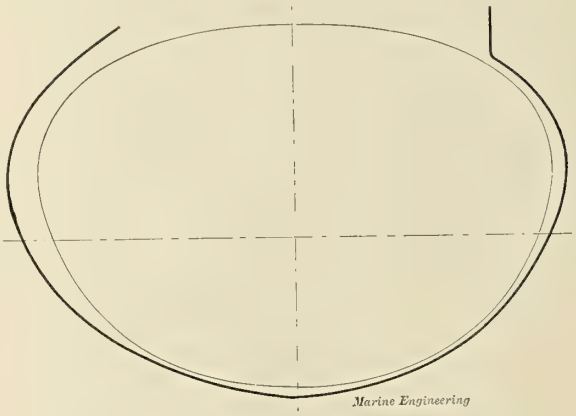
DISASTROUS BOILER EXPLOSION ON THE AUSTRIAN TORPEDO BOAT ADLER.*

BY J. HEINZ.

Since the wreck of the frigate *Radetzky*, which occurred thirty years ago, the Austrian navy has never had to record a greater disaster than that which occurred to H. M. Torpedo Boat *Adler* on July 22, 1899.

This vessel was built by Yarrow & Company, Ltd., London, in 1885, and was of the following dimensions: Length, 135 ft.; beam, 13 ft. 9 in.; mean draft, 5 ft. 6 in.; displacement, 95 tons, and bunker capacity, 28 tons. The engine developed a maximum power of 1,200 I. H. P., giving a speed of 22.2 knots. The boiler was built by Hicks & Hargreaves, of Bolton, Manchester, England, and was of the locomotive type, as adapted for marine work, and was connected to two funnels placed athwartships of each other.

The vessel had been ordered in commission for the summer of 1899, and after the usual overhauling, cleaning and scaling, and dock trial, she left her anchorage at Teodo at 6 A. M., July 22, for a run to Sebenico. The crew consisted of 17 men. As is customary for long runs, she was run under reduced speed, making



CROSS SECTION BEFORE AND AFTER EXPLOSION.

12 1-2 to 13 1-2 knots, with 220 revolutions per minute of the engine, and carrying 120 lb. of steam.

About three o'clock in the afternoon, the vessel being three miles off shore,† an explosion took place without warning or premonition of any kind. It manifested itself by a heavy vibration and roar, followed immediately by a sharp report. Then a hail of splinters fell on the deck and a shower of hot water from the boiler fell on the after deck. For a time the vessel was enveloped in a cloud of steam, and after this had disappeared the survivors were able to get an idea of the damage. Of the crew, two were killed by falling timbers, three were hurled out of the vessel and drowned, and four were more or less injured. The deck over the boiler room was torn up and showed a gaping hole, as the boiler had torn itself from its fastenings by the reaction of the escaping steam and had hurled itself bodily overboard. The mast of the ves-

*Translated from the original German of *Mittheilungen aus dem Gebeite des Seewesens*, Pola, Austria.

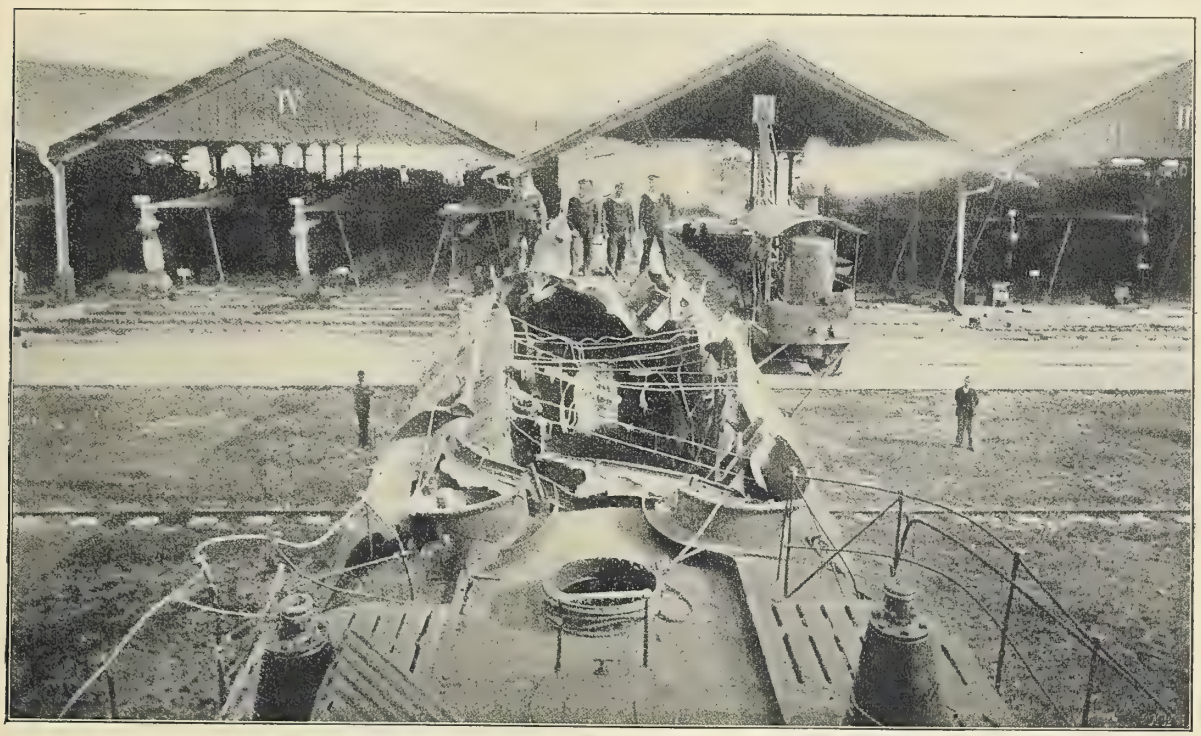
†The disaster occurred while the *Adler* was steaming in the Adriatic Sea, near the Isle of Lesina, off the coast of Dalmatia.—Ed.M.E.

sel flew upward and fell on the deck, the starboard stack hung over the side of the vessel, and the port stack was bent forward. The bulkhead between the engine and boiler rooms was broken through at its upper parts, and all gear on deck above the boiler room, such as small boats, etc., had disappeared. The deck aft of the boiler room looked like a scrap pile, but the deck forward suffered little damage.

After an unsuccessful attempt to rescue one of their comrades who was hurled overboard, the survivors set to work to save what was left of the vessel, as she began to roll heavily and shipped water. A sail was rigged with awnings and spare spars, and she was laboriously worked to shore and beached. The engine and boiler rooms had meanwhile filled to the water level. Divers were sent down to stop the leaks, and after the boat was pumped out she was towed to the naval station at Pola for survey and investigation. A comparison between the boiler, with the exception of those which were covered with coal. Of the two main steam pipes, the port pipe had torn off at the boiler stop valve, but was intact, while the starboard pipe was sheared off at the engine room bulkhead. The entire engine space was intact, except that it was filled with soot and ashes.

The boiler was 18 ft. long, the cylindrical part was 7 ft. 7 1-2 in. dia., 8 ft. 9 in. between tube sheets; grate surface, 40 sq. ft.; working pressure, 150 lb. The boiler weighed 35,300 lb. when empty. The boiler was one of the largest of its kind, and was a duplicate of the one on the sister boat, the *Falke*. The fire box was made of copper plate, the tubes of brass, and all mountings were in duplicate.

The boiler, although built in 1885, had seen very little service. It had been tested with cold water pressure to 240 lb. per square inch four months previous



APPEARANCE OF BOILER ROOM FROM THE DECK OF THE ADLER SUBSEQUENT TO THE EXPLOSION—PHOTOGRAPHED AT POLA.

the vertical section through the boiler room before and after the explosion showed that the pressure due to the reaction of the steam had bulged out the sides and the bottom, and portions of the framing which, on superficial examination, seemed to be sound, were tested and found to have far exceeded the elastic limit. The boiler breeching was intact at its lower end, but the upper part was badly injured. The boiler saddles were partly bent and partly torn off, and the ash pan still remained in place, although bent. Among the ashes and clinkers which remained in the ash pan were found copper rivet heads and sheared rivets, which had come from the fire box seams, as well as pieces of sheared staybolt threads. The boiler mountings had all gone with the boiler, with the exception of one safety valve, which was picked up in a damaged state. The stokehole floor plates had also gone with to the accident, and had also a dock steam trial with full boiler pressure. Furthermore, it had been caulked and several staybolts renewed.

According to the testimony of the survivors of the crew, the boiler had had an examination and cleaning two days previous to the accident. The braces and tubes were found clean, and the vertical stays were slightly rusted. There were no defects of any kind, with the exception of a slight pitting at the bottom hand holes. The refuse removed during cleaning consisted only of rust scales. There was no doubt that all accessible parts of the boiler were clean, but the condition of the bottom of the water legs unfortunately could not be ascertained. The boiler feed had always been fresh water, and the water level indicators were always in good condition. The amount of auxiliary feed required was minimal, and the salinometer tests

had shown the water to be pure. As the boiler room crew had been killed, it was impossible to find out the exact state of affairs shortly before the explosion, but it was noticed that an hour and a half previously water stood slightly high in the glasses.

The commissioners appointed to investigate the cause of the explosion were convinced that the rupture occurred in the seam at or near the top of the fire box. No definite reason could be assigned to the cause of the break.

An attempt was made to drag the bottom of the sea at the place of accident to recover the boiler and thus get better evidence. Four navy vessels worked for twelve successive days at this task, using every modern appliance, but were unsuccessful, as the water at that spot averaged 230 ft. in depth, and the bottom consisted of jagged rock and coral, with steep declivities.

The possible causes of the rupture of the fire box could have been either a heavy deposit of scale, or low water. The first conjecture, of course, is out of the question. The second could have occurred, as follows: The feed pumps had always been in prime condition, and there may have been a possibility that, knowing this, the crew had been somewhat negligent in attending to them, and a probable stoppage of feed might have been the cause, as it was stated that the quantity of water in the boiler could be evaporated in seventy minutes. Then again, an examination of the water chamber of the pump shortly after the accident revealed that the contained water was salty, and therefore a probability that a sudden breakage of a condenser tube or leakage in the condenser would account for the extra height of water in the glass previous to the accident.

PORT AT MONTAUK POINT.—The control of the Long Island (N. Y.) Railroad passing into the hands of the Pennsylvania R. R. recently has revived rumors of the construction of a great railroad and steamship terminal at Montauk Point for transatlantic trade. The Point is about 117 miles by rail from New York city, and were passengers to be put ashore there instead of coming up to New York by water the duration of a transatlantic trip would be shortened by about seven hours.

THE NAVAL STEAM ENGINE—ITS GRAPHICS AND ECONOMICS ILLUSTRATED—II.

BY ROBERT H. THURSTON.

IN ILLUSTRATION, let it be required to ascertain the Carnot efficiency and the values of these quantities for cases in which the initial pressures range from 160 down to 60 lb., while the back-pressure is constant at 4 lb. In this, as in all other cases, the work is all performed by transformation of latent heat of expansion; all energy, U, furnished the cycle is latent heat, H_1, and the efficiency is $E = (T_1 - T_2) / T_1$; while the work done is always measured by the expression $U = EH_1$. Then the quantity of heat, of steam, or of fuel required to supply the precise equivalent of the conventional horse-power, 1,980,000 foot-pounds per hour, or 33,000 per minute, as, for example, when 10,000 *B. T. U.* being taken as the heat-content, so far as available, of the fuel, we invariably have for the measure of these quantities for efficiency unity, 2,545 *B. T. U.*, 0.2 pounds of fuel 2,545 / H_1 pounds of steam per horse-power-hour, These figures, divided by the computed actual efficiency of the cycle, give the measures of the quantities of heat, steam and fuel demanded by the cycle per horse-power-hour. These quantities have been computed and tabulated, as in Table I, for the above assumed range and conditions.

TABLE I.—IDEAL EFFICIENCY OF CARNOT CYCLE CONDENSING.

Initial steam pressure #per sq. in	p_1	160	140	120	100	80	60
Initial steam pres. #per sq. ft	P_1	23,040	20,160	17,280	14,400	11,520	8,640
Initial temp. deg. Fahr	t_1	363.346	352.827	341.058	327.625	311.866	292.575
Volume of 1# water at initial pressure	V_0	.0160	.0160	.0160	.0160	.0160	.0160
Volume 1# steam at init. st. pr	V_1	2.786	3.161	3.656	4.342	5.358	7.024
Back pressure #per sq. in	p_2	4	4	4	4	4	4
Back pressure #per sq. ft	P_2	576	576	576	576	576	576
Temp. at back pressure	t_2	153.122	153.122	153.122	153.122	153.122	153.122
Vol. at end of ex. p. per app. form	U_2'	71.85	72.45	73.17	73.96	75.03	76.33
Ratio of expansion per app. form	$r.'$	25.79	22.92	20.02	17.03	14.00	10.87
Vol. at end of expansion	U_2	71.76	72.54	73.69	74.36	74.77	76.56
Ratio of expansion	r.	25.75	22.95	20.16	17.12	13.95	10.89
Thermodynamic efficiency	E.	.255	.245	.234	.221	.205	.185
Latent heat of 1# steam at in. pr.	L	857.912	865.552	874.076	883.773	895.108	908.928
Work per stroke in B. T. U.		218.77	212.06	204.53	195.31	183.50	168.15
Work per stroke in ft. lbs	W	170,203	164,983	159,124	151,951	142,763	130,821
Horse power per stroke per min.	H.P.	5.16	5.00	4.82	4.60	4.33	3.96
M. E. P. in# sq. in	p_E	16.47	15.79	14.99	14.19	13.26	11.87
M. E. P. in# sq. ft	P_E	2,371.8	2,274.3	2,159.3	2,043.4	1,909.3	1,708.7
Steam per H.P. per hr.		11.63	12.00	12.44	13.05	13.87	15.13
B. T. U. per H.P. per hr		9,980.39	10,387.75	10,876.07	11,515.84	12,414.63	13,766.75
Fuel per H. P. per hr.		.998	1.0387	1.0876	1.1515	1.2414	1.3756
Volume traversed by piston, per H P. per minute		13.90	14.51	15.29	16.16	17.27	19.33

Comparing the figures, it is seen that, could the engineer approximate the ideal case with his real engine, he could obtain the horse-power at the cost of but from 11.9 to 16.5 lb. of steam per hour with condensing engines, adjusted as assumed. The back-pressures, which have been taken to correspond, for special purposes of comparison, with the data given by Rankine, are, in these cases, however, altogether too high, and a vacuum 2 lb. better, and with a more than corresponding gain, is often reached, reducing these figures something like 15 per cent for the best known cases.

The Rankine Standards are those which are commonly taken for employment when it is desired to ascertain what are the magnitudes of the more or less avoidable wastes of the steam-engine. Of these there are two:—

The Rankine Adiabatic Cycle is one in which steam is assumed to enter a non-conducting cylinder, to be expanded to terminal pressure, adiabatically, to be free-

ly exhausted, with uniform and minimum back-pressure and completely rejected, no clearance or compression being allowed.

The Rankine Jacketed-Engine Cycle is one in which steam, entering as before, is expanded in a cylinder capable, as by the use of a jacket or otherwise, of supplying it with all the heat needed, in the course of the expansion period, to keep it precisely dry and saturated, up to the instant of opening the exhaust port. The remainder of the cycle is similar to that of the adiabatic cycle.

The computation of these ideal cycles may be made by processes of great simplicity and ingenuity, fully described by their author, and now quite familiar to the professional engineer. They need not be here described in detail.[1]

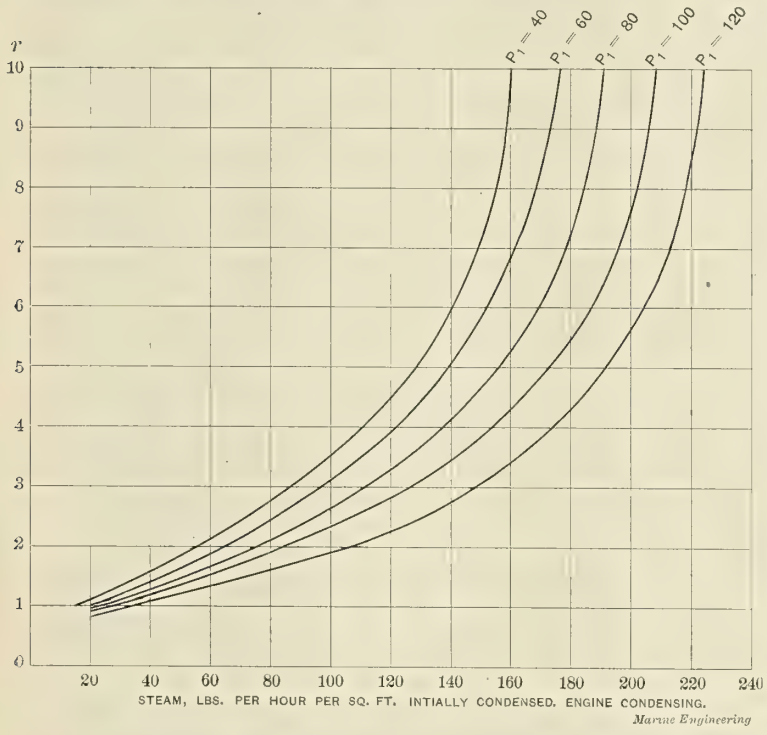


FIG. 3.—CYLINDER CONDENSATION AT MODERATE SPEEDS OF ENG IN E.

Of the two type-cycles, that known as the jacketed engine cycle is more nearly illustrated by the real engine, where its jacketing is effective, than is the other. No engine-cylinder, as yet, has been made adiabatic in its action.

The data assumed for a Rankine jacketed-engine cycle, as follows, are as nearly those of an actual case in practice as it is possible to make them.

TABLE II.

DATA FOR COMPUTATIONS AND RESULTS.

p_1=121.6+14.5=136.1; p_3=2.8 lbs. per square inch; T_1=811.8° F. Correct efficiency, 0.283.

r	p_2	T_2	V_2	U	Thermal Efficiency.	Steam per H P. per hour=W'.
15	7.68	642.2	48.93	206,600	0.232	9.61
20	5.55	628.0	66.40	214,600	.252	9.23
25	4.41	618.3	82.50	219,000	.258	9 02
30	3.63	610.5	98.90	220,380	.259	8.98
35	3.09	604.1	115.25	222,070	.261	8.92

The wastes for such cases may be approximately computed, and, if added to the above expenditures, the sum will presumably be approximately the actual expenditure of the engine; always provided the design and construction be so well and so intelligently carried out as to permit the operation of the machine to be representative of good contemporary practice.

The two formulas most commonly employed in the computation of probable wastes by cylinder condensation, the most remarkable of those wastes which distinguish the real from the ideal case, are the following, in which W is the weight of steam condensed per hour, and W^1 that computed for the ideal case:

$$W=CA(T_1-T_2)t; \quad W'=(W'a\sqrt{t})\div D.$$

A and a are constants determined by experiment; t is the time of one stroke in seconds; and D is the diameter of the steam-cylinder in inches, A its internal superficies in feet.[3]

The magnitude of this waste is rarely fully realized, and the diagram, Fig. 3, illustrating the results of research extending over a long period of time and by a number of observers, as collated, compared and pruned of errors of observation in such manner as to permit their representation by smooth and regularly varying curves, rectified for both curvature and locus, by the writer, may prove instructive. The case is that of one of the experimental engines of Sibley College, and shows how, with engines of moderate size and of moderate speed, 80 to 90 revolutions with 3 ft. stroke of piston, the measured amount of steam condensed on the unit area of internal surface of the cylinder wall varies with the degree of expansion and the changing steam-pressures.

It is seen that, in this case, the wastes are less as the ratio of expansion is less as the steam "follows" farther, and also as the boiler-pressure is reduced. These differences, great at first, become rapidly less as the ratio of expansion increases, the total waste varying pretty nearly as the square foot of the ratio of expansion.

S. S. Grosser Kurfurst.—The *Grosser Kurfurst*, of the North German Lloyd Line, arrived at the port of New York last month on her first transatlantic trip. She is one of the intermediate type of vessels of the fleet, with enormous carrying capacity and excellent passenger accommodation for all classes. Last winter this fine vessel was first put into service, making a trip to Asiatic and Australian ports in the company's service in those waters. She is a product of the Schichau Yard at Danzig. Her dimensions are:: Length, 581 ft. 6 in.; beam, 62 ft.; depth, 39 ft.; gross tonnage, 12,200 tons; displacement, 22,000 tons. She is fitted with twin screws, driven by quadruple expansion, navy pattern, balanced engines, with cylinders, 27 3-8 in., 41 in., 59 in. and 83 1-2 in. dia. and 53 1-8 in. stroke.

[1] See Rankine's Manual of the Steam-Engine, or Thurston's Manual, Vol. I., Chapter V.

[2] For the Rankine equations, see either Rankine's *Steam Engine and other Prime Movers*, or the writer's *Manual of the Steam-Engine*, Vol. I. For the treatment of the real, as distinguished from the ideal, case, see the latter, and especially Chaps. V. and VI.

[3] *Manual of the Steam-Engine*, Vol. I., Chap. VI.

SYSTEM OF WORK ADOPTED IN A SHIPYARD ON THE GREAT LAKES—I.*

BY W. I. BABCOCK.

While the systems used in the construction of the hulls of modern steel vessels are somewhat the same in all lake yards, it is the purpose of the following article to describe the practice of the Chicago Ship Building Co. only, and that as applied to the ordinary lake bulk freight vessel of large size. For a proper understanding of what follows, it is necessary first to describe the ship itself, inasmuch as the requirements of the service have developed a somewhat peculiar type of vessel.

The great majority of modern steel lake vessels are designed to carry only iron ore, coal, or grain in bulk, and no deck, therefore, is required or laid on the main-deck beams in the cargo holds. The movement of ore and grain is entirely from upper to lower lake ports, and of coal in the opposite direction. As, however, there are a great many wooden vessels still in service which require up-cargoes, and coal cannot be unloaded rapidly, the freight rate on coal is seldom attractive, and the big steamers, especially those belonging to the great ore and steel companies, go back light, using water ballast alone when any is required.

The season of navigation being limited by ice to about seven months in the year, despatch in port is of the utmost necessity, and as the cargoes are all spouted in, the ore and coal from elevated docks and the grain from elevators, and taken out by machinery on the docks, hatches are many in number, and no hoisting machinery is carried on the ships themselves.

The connecting channels between the lakes being comparatively shallow, the vessels are built with a plate keel, very flat floor and full model to get as great capacity as possible on the limited draught available, and a large number of frames amidships are exactly alike, as many as one-half to two-thirds the total number. When coming light to a loading dock, they therefore float very high out of water, and to obtain the necessary slope to the spouts the hatches are made as wide as possible athwartships, leaving only stringer enough for strength on each side. While it is true that the upper deck could be depressed by filling the water bottom, this would cause a loss of time in loading, as it is evident that the cargo can be run in much faster than the water could be pumped out, and is, therefore, not allowable.

The longest straight run in open water is across Lake Superior, about 400 miles, the total voyage being under 1,000 miles. Coal for fuel being available at various points in the connecting rivers, no great bunker capacity is required, and, the fuel hatches opening in all cases through the upper deck, a few minutes suffices to spout in the amount desired from elevated pockets. At lower lake ports it is usual while the cargo is discharging to fuel from a lighter alongside provided with a hoisting derrick reaching into the fuel hatch.

The danger of grounding in the narrow, tortuous, and in many places rocky channels connecting the lakes themselves being considerable, double bottoms are a necessity and are carried straight across on top to protect the bilge to the upper turn. To get sufficient water ballast, as well as to raise up an ore cargo and make the ship easier in a seaway, the tank is made deep, from 5 to 6 ft. at the center line. Carrying the cargo at this height above the floors requires heavily stiffened and closely spaced girders or longitudinals, which are intercostalled between floors to further support them and the bottom plating against grounding strains. The use of channel floors for the flat of bottom is now universal, and results in a considerable saving in first cost, as well as avoiding the continual shearing of frame rivets and cracking of frames through the rivet holes from grounding when the bottom construction is the ordinary plate floor with frame and reverse bar.

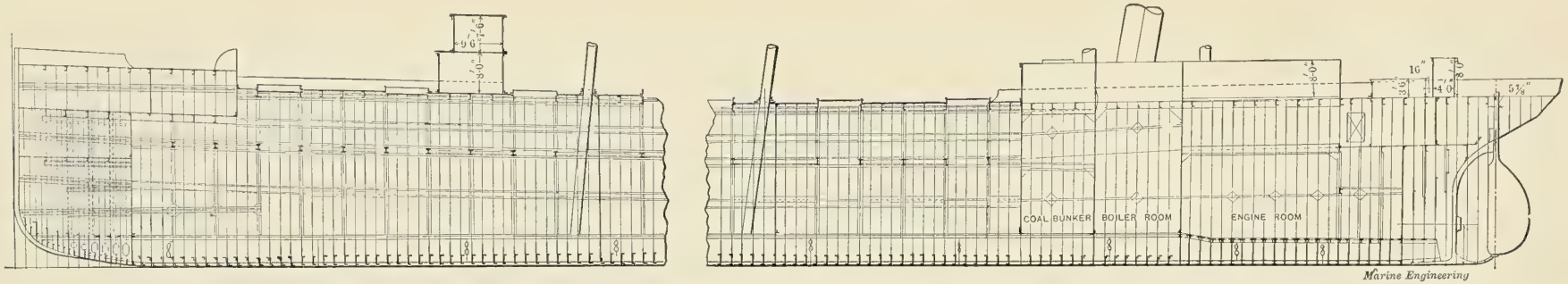
Ore and coal loading docks having the spouts uniformly 12 ft. centers, all hatches are spaced 24 ft. centers fore and aft, and the frame spacing is always 24 in., no matter how large the ship, the frames being channels. Hatches are 8 ft. fore and aft and channel web frames or belts are spaced every 8 ft., making one belt at each hatch beam and one in the center between hatches, on which a main-deck beam is also placed. To avoid interruption of the loading spouts by machinery spaces, as well as to avoid the inconvenience of a shaft alley in the cargo hold, the machinery is placed aft, the engine going as near the stern-post as the shape of the ship will permit, and the boilers and bunkers being next forward, either in the hold or on a raised deck, with cargo space beneath.

From all of the above considerations a type of vessel has been developed, of which the S. S. *Mauna Loa*, of the Minnesota Steamship Co., just completed in the Chicago yard, shown in the accompanying engraving, may be considered a fair example. The ship is 430 ft. keel, 450 ft. over all, 50 ft. moulded beam, and 28 1-2 ft. moulded depth, with a 5 1-2 ft. water bottom. She is propelled by a quadruple-expansion, four-crank, jet condensing engine of 2,500 H.P., taking steam at 250 lb. pressure from two Babcock & Wilcox marine water-tube boilers. The light-load displacement is about 3,200 net tons, and on 18 ft. 3 inch draft she carried 6,816 gross tons of iron ore. The water ballast capacity is 2,900 net tons. Speed, loaded, 12 statute miles per hour, and light, 14 miles.

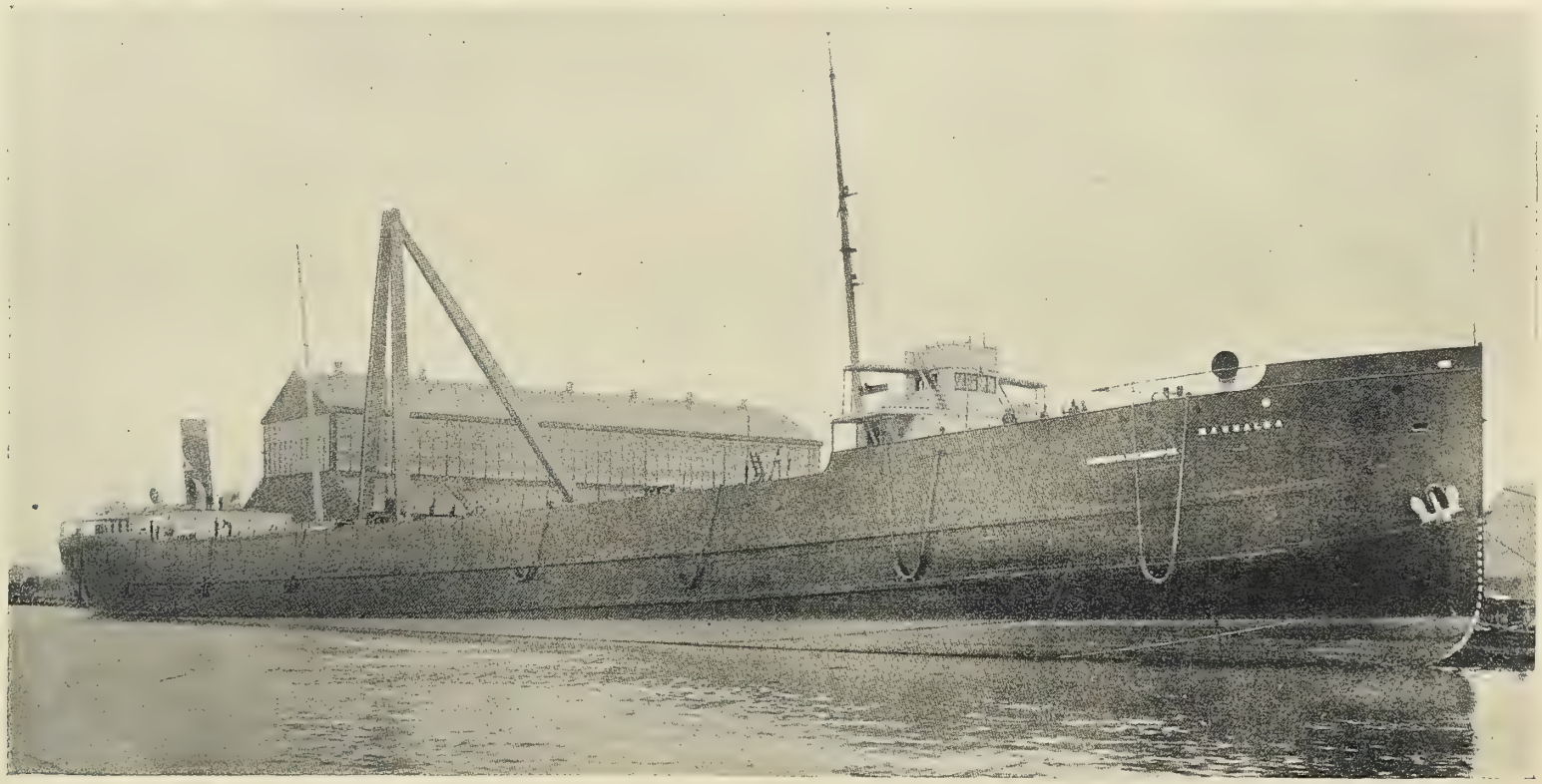
The system used in the Chicago yard in constructing this ship and similar vessels is as follows:

The general dimensions, midship section, and positions of hatches and bulkheads having been agreed upon, a model is prepared, and from it the length of the straight midship portion of the ship determined. At the same time, a butt plan of the keel, bottom plating, center keelson, rider, longitudinals, tank margin, and all fore and aft angles is prepared, and on the mould-loft floor a reproduction of the midship section drawing is made full size. From this the widths of the various bottom and bilge plates are measured exactly, the necessary allowances made on the outside plates for bevel shearing and the mill orders prepared at once. Wooden templets for the brackets at center keelson, bilges, tank top, and deck beams are made with the necessary allowance for flanged edges and sent direct to the plate mill, so that all these brackets come into the yard

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.



FORWARD AND AFTER ENDS OF STEEL LAKE FREIGHT STEAMER MAUNA LOA BUILT BY CHICAGO SHIPBUILDING CO., SOUTH CHICAGO, ILL.



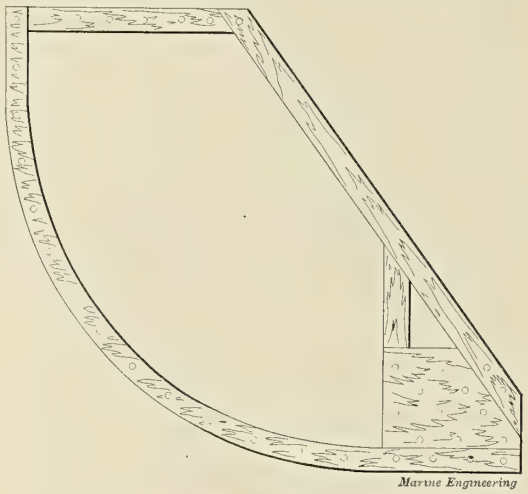
PHOTOGRAPH OF LAKE STEAMER MAUNA LOA (450 FT. LONG, 6,800 TONS CAPACITY) WHEN LIGHT AND LYING ALONGSIDE WHARF AT BUILDERS' YARDS.

sheared to exact size. The lengths of the channels for floors and tank-top seam straps, and of the angles for the keelson and longitudinal stiffeners, bilge frames, etc., are taken directly from the floor and orders sent to mill.

It will be understood, of course, that as there are a large number of dead flat frames—114 in this ship—this enables a large quantity of material, both plate and shapes, to be ordered in duplicate pieces from the floor very quickly from the midship section only, and without waiting for the body plans to be completed.

After the lines are faired and the body plans completed on the floor, the remainder of the ship is ordered in the usual manner. The laying down in the loft being completed, the next step is the making of the wooden moulds. For the straight part of the vessel amidships, below the tank top, it is evident that one mould only is required for the channel floors, with strip (narrow) moulds for top and bottom flanges, one for the ordinary bilge brackets, and one for the belt bilge brackets, from which all are punched. Also that one mould each suffices for the center vertical keelson and rider for all the plates from the forward collision to the engine bulkheads, the keelson being of uniform depth, and one keel mould answers for all the keel plates until the floor line at either end leaves the dead-rise line within the half breadth of the keel plate. For this keel mould, as well as for all moulds for butted plates, strips of lignum-vitæ, adjustable for screws, are fitted into the ends, so that any variation in length from swelling or shrinking of the pine from which the mould is made can be taken up and the exact length secured. When lapped butts are used this refinement is not required. One mould also answers for nearly all of the center vertical keelson brackets; two moulds for C. V. K. angles, one for each flange; one for the stiffeners of each longitudinal for all the flat of bottom; two for keel bars; two for top C. V. K. angles; two for channel seam straps under tank top; two each for top and bottom longitudinal angles; one for the high plate floors dividing the separate compartments of the water bottom. For the skin plating on the flat of bottom one mould suffices for all the plates in each strake. Similarly, one mould answers for all the tank-top plates except where the water-tight floors would come at a seam, which is undesirable for water-tightness, and, therefore, avoided by putting in a narrow plate, and one mould for all the tank-top margin plates amidships.

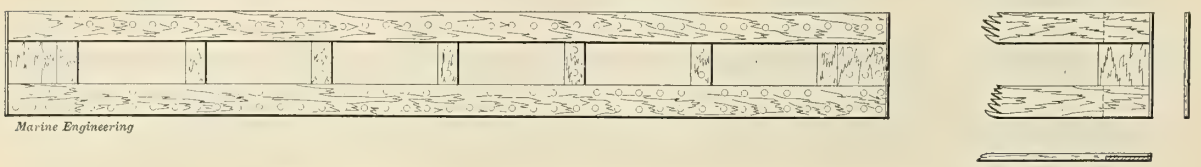
In laying out all fore and aft members, both plates and angles, from these moulds certain allowances must be made, as follows: Where the turning space comes—that is, where the siding flange of frames and floors changes from looking aft to looking forward—the distance between frame rivets, instead of being exactly 24 in., is less by twice the distance from heel of floor to center of rivet, and the mould must be moved up that amount. Where the water-tight plate floors come, the moulding side of the frame is moved a distance equal to the thickness of the plate, as is also one center keelson stiffener, the rivet spacing is lessened for water-tightness, and extra holes put in on outside strakes of bottom plating for the wide liners. At the belt floors, the small bracket connecting the longitudinal stiffener to the channel seam strap shifts the stiffener over by the thickness of the bracket and necessitates a liner of corresponding thickness between the stiffener and the floor. And wherever a butt comes in an adjoining member, requiring different spacing of rivets, these must be allowed for.



BILGE BRACKET MOULD.

In all such cases, "space moulds," covering only the particular frame space in which the change is necessary, are applied after the remainder of the member has been laid out from the regular mould. It is evident, therefore, that a very large amount of material, both plate and shapes, sufficient to build almost the entire water bottom of the ship for the straight midship body, and a considerable part of the material for some distance forward and aft of same, can be gotten out rapidly, from a very small number of moulds, ready to go into place, before the keel is laid.

The practice of the Chicago yard, as of all other Lake yards, is to build the ship on level stocks and launch sideways. The keel blocks are now set, one to each keel plate, by a surveyor's level, and the center line put in by a transit instrument, the keel plates are strung along on them, the butt straps and liners bolted up and four tack rivets driven by hand in each strap to avoid possibility of shifting. Then one keel bar is put



MOULD FOR ONE-HALF OF KEEL—UPPER EDGE CENTER LINE OF KEEL.

up, the center vertical keelson plates and butt straps, the other keel bar, keelson top angles and stiffeners and all carefully bolted and reamed. A large amount of work is thus ready for the pneumatic yoke riveters, which are then started and the whole keelson riveted and caulked water-tight.

In the meantime the various parts composing the floors have been punched, assembled on a long line of skids extending from the stationary steam riveter, tested by the mould, bolted carefully and reamed by pneumatic drill and riveted. It will be noticed that of all these pieces—namely, the channel floor, center keelson bracket, bilge bracket, bilge frame, longitudinal stiffeners and clips—only one piece, the bilge frame angle, has any curve to it. This angle is bent cold between two collars temporarily bolted to the upper roll of the shipyard bending rolls, the bilge being made an arc of a circle to facilitate this rolling as well as that of the bilge strakes of the hull plating. For more than half the length of the ship, therefore, there is no furnace or forge work in any part of the water bottom except the few angle collars required to make water-tight work at the tank divisions. This applies also to a considerable part of the water bottom forward and aft of the straight midship body, and, as will be seen hereafter, to a large part of the ship above the tank top.

Forward and aft of the midship body the channel floors are continually growing shorter and the bilge brackets longer, as the extremities are approached. The bilge bracket soon becomes too large if its inner edge is kept straight, and it is, therefore, cut out to a curve and fitted with a reverse frame. When the channel diminishes to about 6 ft. in length its use is abandoned and ordinary plate floors with frame and reverse frame substituted.

While one diminish mould for each body answers for the floor channels, separate moulds for each bilge bracket must be made. When bolting the various parts together, however, to make the complete floor, the same test moulds answer as are used for amidships, the position of the outboard upper point of each frame being marked upon them, so that all the floors from one end to the other of the water bottom are completed and riveted at one time.

The center keelson having been riveted and caulked, heavy floor ribbands are now erected at each side at a distance from the keel just inside the extremities of the floor channels. The garboard plates are now raised into position, bolted to the keel plate on the inner edge and held up by temporary vertical shores near the outer edge. Similarly the other strakes of the bottom plating for all the flat part of the bottom are put up in succession and supported in the same way. The total weight being small, only very light shoring is required. The floors are now brought over by a locomotive crane from where they were stored, after being riveted on the bull machine, and dropped into place on top of the bottom plating by the overhead traveling crane. The inner end rests on the keel and the outer end on the floor ribband, a bolt or two through the bracket and keelson stiffeners being put in at the same time. Quickly thereafter the longitudinals and intercostals are put in, the channel seam straps rove across, and the whole carefully leveled and squared up, one or two tank-top plates being put on to hold everything secure.

FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN—III.*

BY LIEUTENANT COMMANDER GEORGE H. PETERS, U. S. N.

PERSONNEL.

Efficiency of the personnel is universally recognized as of supreme importance.

In no direction does this manifest itself in a more marked degree than in the intense and continuous effort shown abroad to train gun pointers, with the object of having them attain the greatest possible practical efficiency. Prior to the war with Spain the published statements of results of foreign target practice gave some remarkable percentages of hits. Since the war, owing to greatly increased interest in the subject, still better results are said to have been achieved.

Not making sufficient allowance, perhaps, for battle conditions, foreign analysis of the effects of gun fire at Manila and at Santiago generally results in the assertion or points to the inference that the American gun pointers showed much room for improvement, both in the accuracy and in the rapidity of their fire, although they were vastly superior to the Spanish. In so far as these discussions are derogatory to the American gun pointers the comment is appropriate that never before have fleets been so utterly destroyed through gun fire.

In the British navy the allowance of ammunition for target practice and the amounts paid for prize firing have, it is stated in the press, been largely increased within the past year. The *Excellent* gunnery training establishment on Whale Island has been enlarged, and improvements are making to increase the facilities for target practice. The Sheerness gunnery school is reported in the press to be undergoing enlargement. English newspapers report negotiations in progress to secure land to permit the *Cambridge* gunnery school at Devonport to be established on shore, in accordance with the method followed at Whale Island. The same plan adopted there will probably be adhered to of having vessels to carry details to sea frequently for target practice, underway, under varying conditions of weather.

In the French navy the training of gun pointers has for some time past been a matter of special effort, and since the recent war these efforts have been redoubled. The exercises appear from press accounts to be of a very practical nature.

In the German navy prizes are offered for successful target firing to a greater extent than formerly, and nothing is left undone to stimulate interest in the practice. Press reports show that the vessels in commission at Kiel and Wilhelmshaven go to sea almost every day for target practice, which is not confined, as formerly, to their going out for manœuvres. Target practice is no longer confined to ships in commission, but also includes the vessels in reserve, which go out with reduced complements, in order to familiarize the personnel with the ships and to keep the vessels in serviceable condition.

Training is by no means confined to target practice,

*From Notes on Naval Progress issued by U. S. Office of Naval Intelligence, Washington, D, C.

but goes on actively in every practicable way in all important foreign navies.

The tendency is very marked abroad to have men who are selected for special courses of instruction, as well as those awaiting distribution to the fleet, quartered in barracks ashore rather than on board of old hulks. It is found that better hygienic conditions can be obtained in barracks, and the results are more satisfactory in many ways.

Rapid coaling is now regarded as an essential requirement of the personnel and has received much attention, particularly in the British navy, where it is no longer regarded as mere drudgery, but has become an important evolution in which officers as well as men often take part, the greatest rivalry existing among the ships of a squadron.

Items which have appeared recently in English newspapers indicate that, through thorough training of the fire-room force, marked progress has been made in the extremely important matter of diminishing the amount of smoke discharged from the smoke pipes.

The problem of securing an efficient naval reserve has long been a subject of serious study abroad, particularly in Great Britain, where the question assumes special importance, owing to the manning of the fleet being there dependent upon voluntary enlistment. The measure now in force in the British navy requiring new reserve men to serve on board ships in commission for a sufficient time to give them some idea of naval duties will, it is believed, have good results.

MOBILIZATION.

The importance of rapid mobilization is fully appreciated in foreign navies. Some of them, profiting by the experience gained in the annual tests in connection with naval manœuvres, have reached a high degree of proficiency in this respect, as is demonstrated by the facility with which officers and crews go on board strange ships to be temporarily commissioned, assume their duties at once, enter promptly upon the service to be performed, and upon its completion lay up their ships and turn in their stores without delay. The prompt mobilization last year upon short notice of a British reserve fleet, including well-drilled flotillas of torpedo boat destroyers, in view of threatening foreign relations, afforded a notable example of the value of practice in such work.

NAVAL LEAGUES.

A movement in connection with naval matters which has received a remarkable impetus within the past few years in several maritime countries is the development of naval leagues—associations having for their chief aims the diffusion in popular form of information concerning the navy of the nation and advocacy of its maintenance and increase.

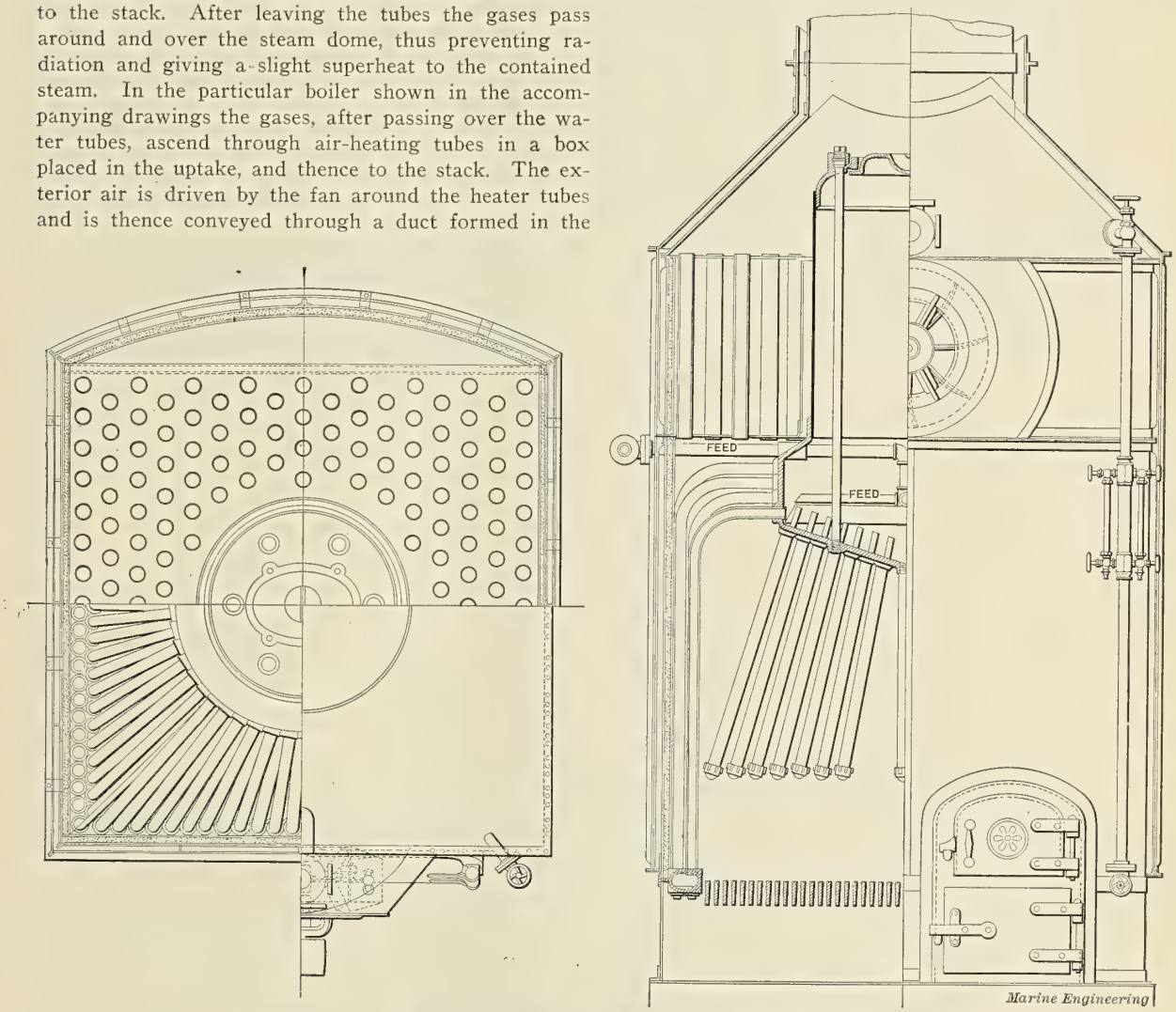
PIGEON POST.—Vessels of the French Line leaving New York recently have carried away carrier pigeons, which were released when the vessel had been out 24 to 48 hours. The pigeons belong to a cote in Malden, Mass. Messages from the ship's officers and passengers are reduced to a very small compass by the usual photographic process, and incased in a tiny aluminum tube, which is secured to the bird's leg before it is sent off. On a recent east-bound trip of the *Touraine*, her commander dispatched six birds when 300 miles out.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—VI.

Ward Water Tube Boiler.

This description of the Ward water tube boiler refers particularly to the type for small boats and vessels, such as are used almost exclusively in the steam launches of the U. S. Navy. Charles Ward, the inventor and builder, has designed water tube boilers of a variety of types, suiting the design to the special requirements of each case. Of the larger types of Ward boiler the best known, perhaps, is the coil boiler as fitted in the U. S. S. *Monterey*. The boiler here described differs from the navy launch type in that it is fitted with a self-contained system of forced draft, as will be readily seen upon inspection of the accompanying drawings. The type of boiler here described is built both square and round in plan view, that shown being the square boiler. It consists of a combination of plain bent water and straight Field tubes, with an upper central receiver and a lower manifold or base ring carried around the boiler at the grate level. The firebox is wholly composed of tubes, and no fire bricks are used in the boiler. The firebox is surrounded by a double wall of plain water tubes that rise vertically from the bottom manifold; and at their upper extremities are curved sharply inwards and are expanded into the central receiver. It will be noticed that the tubes rising from a square base enter a circular receiver, each one not radially, but at an angle peculiar to itself, as shown in the plan view. This necessitates very careful construction. The bottom of the central receiver, which forms the crown sheet of the furnace, is not flat, but an inverted cone. Into this are screwed the upper ends of the straight, pendant, Field tubes. They are arranged in concentric circles and project downward, at a slight angle to the vertical, into the combustion chamber. To insure a regular circulation in the Field tubes the upper end of each is closed by a diaphragm in which two tubes of smaller diameter are expended. One, for the downflow, extends from the diaphragm to within 1-2 in. of the bottom of the interior of the Field tube, and the other is a short tube which extends upward from the diaphragm and delivers the ebullition at a point well above the source of supply to the Field tube. Each Field tube is fitted at its lower end with a steel cap, threaded left hand, while the upper end, connecting with the central receiver, is threaded right hand. Thus in removing a bottom cap, with a wrench, the operation tends to tighten the tube in place, while if the tube is to be removed bodily the reverse rotation secures this result without fear of the cap coming away alone. The feed water is carried into the central receiver and is discharged through four radial pipes outside an annular metal ring which encircles the Field tubes and separates them from the outer water tubes. These four feed outlets are close to the upper ends of the inner row of bent water tubes (see drawing), and the feed supply therefore takes the shortest route down this inner row of tubes to the tubular base ring or manifold at the bottom, and from there ascends through the other rows of bent tubes to the central receiver again. The heating of the feed water in this manner causes all the foreign matter contained in it to be deposited in the

base ring, whence it can be blown out through suitable openings. Both the cone-shaped receiver and the base ring or manifold are steel castings with holes cored out and afterward accurately machined. Extending upward from the top of this central receiver, inside the casing, is the steam dome, the cover of which is secured to the bottom of the central receiver by long stay bolts. A manhole in the top of this dome gives ready access to the interior of the receiver. In operation the gases ascending from the fire meet the Field tubes and are broken up, before passing to the sides and over the horizontal ends of the bent water tubes on their way to the stack. After leaving the tubes the gases pass around and over the steam dome, thus preventing radiation and giving a slight superheat to the contained steam. In the particular boiler shown in the accompanying drawings the gases, after passing over the water tubes, ascend through air-heating tubes in a box placed in the uptake, and thence to the stack. The exterior air is driven by the fan around the heater tubes and is thence conveyed through a duct formed in the back casing to the under side of the grate. Airtight doors close the ash-pit in front, and the fire door frames are made hollow and are fitted with numerous nozzles through which air can be admitted above the fire to facilitate combustion. A double metal sectional casing is fitted around the entire boiler and is filled with nonconducting material, and outside of this again there is an air space within the outer casing, and which extends from the ash pan to the funnel. The boiler is patented and manufactured by Charles Ward, Charleston, Kanawha County, West Virginia.



SECTIONAL PLAN AND ELEVATION OF WARD WATER TUBE BOILER—SQUARE TYPE.

PAINTS AND VARNISHES USED FOR THE PRESERVATION OF METALLIC SURFACES—I.*

BY PROF. A. H. SABIN.

Ordinary oil paints consist of linseed oil, sometimes more or less adulterated, mixed by grinding with a pigment, which latter is usually a mineral substance reduced to a fine powder. The object of using a pigment, aside from its color, is threefold:

First. It hardens the film, which will thus better resist abrasion. Second. It makes it possible to apply a thicker film, which also wears longer. Third. The particles of pigment tend to fill up the pores which are naturally present in the oil film, and thus the porosity is reduced.

The pigments used for preservative paints are few in number as compared with those used in house or other decorative painting. They may be described briefly as follows:

White Lead.—This is a mixture of lead hydrate and

*From a paper read before the Boston Society of Civil Engineers, and contained in the Journal of the Association of Engineering Societies U. S. A.

carbonate, and is sometimes sold as a dry pigment; but more frequently as paste white lead, which is nine parts dry pigment ground with one part by weight of raw linseed oil. This may be made into a paint by thinning it with oil, and usually a little turpentine is also added. The object of the latter is not to cheapen it (indeed, at the present time turpentine is worth more than oil), but to make it work more freely under the brush and to increase the proportion of pigment in the film. This is a matter which it is very easy to overdo, and if too much turpentine is added there will not be enough oil to act as cementing material for the pigment, which will then be easily removed.

White lead is especially liable to suffer in this way, since it normally takes less oil than any other pigment, and, moveover, it seems to have a natural tendency to combine with the oil. This combination causes the oil to lose its coherence, and then the surface of the paint easily rubs off. As painters say, it chalks. No doubt a great deal of the bad name of white lead is due to this excessive and improper use of turpentine, which is liked by the painter also because it makes the paint much whiter than it is when oil is used, and because it dries rapidly, owing to the volatility of the turpentine.

White zinc is an oxide of zinc, white in color, and it requires more oil than white lead. It is less opaque; its opacity or covering capacity is usually estimated as three-fifths that of white lead. Paint made with it does not readily brush off as a powder, but sometimes seems to come off in flakes. Painters say it peels or scales. It is commonly used mixed with white lead, and the mixture seems to be better than either substance alone. Paints made with these pigments are frequently, perhaps it may be said commonly, adulterated with other white powdered substances, such as kaolin and barytes, which are not particularly harmful, and whiting or carbonate of lime, which is actively injurious. While dry these substances appear white, but when mixed with oil they seem to be transparent. They are without value as pigments, and must be regarded as adulterants.

White lead and white zinc are practically the only white pigments, and must form the basis of all light-colored paints. Other light colors are made by adding some tinting material to them. The principal yellow color is chromate of lead, or chrome yellow. This is a very brilliant color, rather deep in shade, and the pale shades are made by adding white lead. Chrome green is a mixture of chrome yellow and Prussian blue, and is the only green pigment in common use. Prussian blue is a ferrocyanide of iron, dark blue in color. The common light blue pigment is ultramarine blue, an artificial product of complex constitution, the exact composition and preparation of which is a secret. The yellows, greens and blues are not much used in paints for structural work, but this is not the case with red pigments, the most important of which are the oxides of iron. For this purpose the sesquioxide, which is known in mineralogy as hematite, and the hydrated sesquioxide, or limonite, are used. Usually the two are mixed together in various proportions, the pigment being produced by grinding a natural oxide rock, which commonly contains from 10 to 60 per cent. of other mineral matter, commonly silicates. The color of these oxides varies from bright red to dark brown, the bright shades commonly containing most hydrated oxide and the brown (rarely dark purple) shades being chiefly anhydrous; oxides of a bright purple or maroon tint are, however, hydrated. It is commonly believed that the brown or dark red shades, that is, the anhydrous oxides, are more durable than the others. Some of these oxides are of artificial origin, such as Venetian red, which is a by-product, originally containing some sulphuric acid, to neutralize which it has been saturated with lime; and in consequence the finished pigment contains a large percentage of sulphate of lime, which cannot be regarded as a desirable ingredient. A knowledge of the chemical constituents of an oxide pigment is therefore desirable. A considerable proportion of silica, or of highly acid silicates, is probably not objectionable, especially if the product is nearly anhydrous; but if there is ground for believing that the silicates themselves are hydrated, they are simply clay, which is objectionable; and if any lime-salts, soluble in water or acid, are present, the material is not suited for the purpose.

Oxide pigments are particularly open to the criticism of being, in many cases, not finely ground, a most serious objection. Any good paint should be so fine that it feels smooth and even when rubbed on glass or porcelain with a palette knife. The importance of fine grinding is not likely to be overestimated. Ochres, umber and sienna are also classed with the iron oxide pigments, and usually contain a little manganese, which increases the drying qualities of the oil. They also contain various earthy coloring matters. The ochres are yellow in color, and the iron oxide in them is hydrated. They are often used in conjunction with white lead or zinc.

Carbon, in one form or another, is the base of all the black pigments. By far the most common of these, as used in structural paints, is graphite. Other black pigments are lamp black (including carbon black) and bone black, the former being produced in many grades, varying in price from 3 or 4 cents to 60 cents per pound. Bone black, which is refuse from the sugar-house black, varies in the percentage of carbon contained, which is usually about 10 or 12 per cent., the remainder being the mineral matter originally present in the bone and containing 3 or 4 per cent. of carbonate, while most of the remainder is phosphate of lime. Lamp black is an absolutely impalpable powder, which has a small amount of oily matter in it, and greatly retards the drying of the oil with which it may be mixed. For this reason it is not used by itself, but is added in small quantity to other paints, which it affects by changing their color and probably their durability. For example, it is a common practice to add it to red lead in order to tone down its brilliant color and also to correct the tendency it has to turn white, due to the conversion of the red oxide of lead into the carbonate.

S. Y. Saghaya.—A new steam yacht for Charles Stewart Smith and his son, H. C. Smith, was launched from the Morris Heights (N. Y.) yard, May 24. The yacht measures: Length over all, 127 ft.; on water line, 103 ft.; beam, 15 ft. 6 in.; draft, 6 ft. 6 in. She is of composite construction, and is fitted with triple expansion engine and boiler, which will give her speed of about 16 miles an hour.

New Harvard Coaching Launch.

A new launch, to be used in coaching the boat crews of Harvard University, was built recently at the yard of George Lawley & Son, South Boston, Mass. The new launch, built to replace one which we understand was accidentally destroyed by fire, is named the *John Harvard*, and is of these dimensions: Length over all, 51 ft. 3 in.; length on water line, 50 ft.; beam, 7 ft. 8 in.; maximum draft, 3 ft. She is a double end, shoal draft launch, built with oak frames, white cedar planking, mahogany deck, washboard, and seats.

The launch is divided into three compartments by steel bulkheads forward and aft of the machinery space. In a fore and aft direction the cockpit takes up 34 ft., the machinery space 13 ft., forward standing room 11 ft., and after standing room 10 ft. The propelling engine is of the regular vertical, inverted triple expansion type, with cylinders 4 1-2 in., 7 in., and 12 in. dia., and

NEW 50-FT. COACHING LAUNCH FOR ROWING CLUB OF HARVARD UNIVERSITY, BOSTON, MASS.

THREE TUGS BUILT AND LAUNCHED ON ONE SLIP AT HARLAN & HOLLINGSWORTH'S YARD—SEE PAGE 262.

7 in. stroke. Steam is generated in a water tube boiler having 11 sq. ft. of grate surface. A condenser of the outside keel type is fitted, and inboard there is an independent air pump 4 in. and 4 in. by 5 in., and a duplex boiler feed pump 3 in. and 2 in. by 3 in. Tobin bronze is used for the propeller shaft, which carries a four-bladed screw 30 in. dia. and 40 in. pitch. The smokestack is double, with a brass outer shell, and is hinged so as to permit the launch to pass under low bridges. On trial a maximum speed of 16 miles an hour was attained with 525 engine revolutions.

Triple Launching at Wilmington.

It is rare that a triple launching takes place in a yard, and rarer still, perhaps, that the three vessels launched are slid off one set of ways. This was the case, however, at the yard of Harlan & Hollingsworth, Wilmington, Del., May 12, when the steel tugs *Wilmington, Harrisburg,* and *Johnstown* were sent into the water one after the other within the space of a very few minutes. The tugs, built for the Pennsylvania Railroad, are of these dimensions: Length, 100 ft.; beam, 22 ft.; depth, 12 ft. 2 in.; displacement, about 230 tons. A photograph of the little vessels, taken just before the launching, is here published. The boats were launched about ten o'clock in the morning, advantage being taken of a high tide. In little more than a quarter of an hour after the wedges were set up on the first tug, the last had taken the water gracefully.

The propelling machinery consists of a compound engine with cylinders 20 in. and 40 in. dia. and 26 in. stroke. Steam is furnished by two Almy water tube boilers.

Work in the Harlan & Hollingsworth yard is at present very brisk. On the ways occupied by the tugs, the new 400 ft. steamship for the Mallory Line will be laid down. Other work in the yard includes the destroyers *Hopkins* and *Hull,* a steamer for the Metropolitan S. S. Co., a steam yacht for Charles Fletcher, of Providence, R. I.; three barges for the Rockland Line Co., two steamers for the Philadelphia Steamship Co., and the reconstruction of the steamships *Foxall* and *Indiana*—the latter being lengthened 40 ft.

T. S. S. La Savoie.—The second of the two new mail steamships for the French Line, New York to Havre, was launched March 31 at St. Nazaire. The launching was an important function at which the French Minister of Marine presided. Like her sister ship, the *La Lorraine,* the *La Savoie* is built under the stipulations of the new mail contract entered into by the company with the French Government. Both these vessels were described in detail in our issue of January last, but it is well to recall the dimensions, which are: Length over all, 580 ft.; beam, 60 ft.; depth, 39 ft. 6 in.; displacement, at mean draft of 25 ft. 3 in., 15,200 tons. On six hours trial the vessel is expected to attain 22 knots speed. She will have accommodations for about 1,000 passengers of all classes, and will carry a crew of nearly 400 all told. The propelling engines will be of the four cylinder, triple expansion type, and single ended Scotch boilers will be fitted. She will be fitted out so as to be capable of receiving a considerable armament of rapid fire guns when needed as an auxiliary cruiser.

LAUNCHES—HOME AND FOREIGN.

S. S. Californian.—This large steamship for the new American-Hawaiian line was launched at the Union Iron Works, San Francisco, May 12. She is of these dimensions: Length, 430 feet.; beam, 50 ft.; depth, at center, 34 ft. 6 in.; draft, 26 ft. She is constructed in accordance with Lloyd's 3-deck rules. Triple-expansion engines will be fitted with cylinders, 27 in., 45 1-2 in., and 76 in. by 48 in. stroke, capable of developing 2,500 I.H.P. Steam will be supplied by four single-ended Scotch boilers. With 8,250 tons dead weight a mean speed of about 10 knots will be maintained at sea. The bunker capacity is 1,500 tons. This is the largest vessel ever built on the Pacific coast. Two similar ships are now under construction at the Roach yards, Chester, Pa. The *Californian* was launched by moonlight between 10 and 11 P. M. Miss Edith Chesebrough, daughter of the vice-president of the owning corporation, broke the customary bottle of wine.

U. S. S. Thornton.—At the Trigg yard, Richmond, Va., the U. S. torpedo boat *Thornton* was launched May 15. The ceremony of christening the new boat was performed by Miss Mary Thornton Davis, grandniece of Captain J. S. Thornton, U. S. N., who was executive officer of Admiral Farragut's flagship at the battle of Mobile Bay, and was mentioned in despatches. The *Thornton* is one of the group of boats authorized by Act of Congress of May 4, 1898. A contract for her construction was signed November 16, 1898, and her keel was laid March 16, 1899. Her dimensions are: Length, 175 ft.; beam, 17 ft. 6 in.; mean draft, 4 ft. 8 in.; displacement, 165 tons. She is to be fitted with twin screws and quadruple expansion engines, and Thornycroft boilers. The estimated trial I.H.P. is 3,000 and the speed 26 knots.

S. S. Tampico.—A steamship designed for service on both the Great Lakes and the ocean was launched at the Craig yard, Toledo, last month. She is of these dimensions: Length, 250 ft.; beam, 42 ft.; depth, 25 ft. Her propelling engines are of the triple expansion type, with cylinders, 19 in., 30 in., and 52 in. dia., and 40 in. stroke. Steam is supplied by single-ended Scotch boilers, 12 1-2 ft. dia and 11 1-2 ft. long. The vessel is built upon the lake model, with the machinery at the extreme after end, but with this difference that the pilot house, instead of being well forward, is located about amidships. Her construction is very strong, and it is expected that in the winter season she will be able to successfully operate on the Atlantic coast, passing through the St. Lawrence Canal on her way.

T. S. S. Minnehaha.—Another monster vessel for the Atlantic Transport Co. was launched at Belfast, Ireland, March 1. She is named the *Minnehaha,* and is of these dimensions: Length, 600 ft.; beam, 65 ft.; depth, 44 ft.; gross tonnage, 13,750 tons. She is fitted with twin screws driven by quadruple expansion engines, with cylinders 30 in., 43 in., 63 in. and 89 in. by 60 in. stroke. Like the other vessels of the fleet she will carry only cabin passengers. Besides the large freight capacity there will be accommodation for many head of cattle.

S. S. Isaac C. Elwood.—A large lake freighter, the *Isaac C. Elwood,* was launched from the Bay City yard of the American Shipbuilding Co., May 5. This vessel was built for the American Steel & Wire Co.'s interests, and is the third of the 500 ft. fleet, the others previously launched being the *John W. Gates* and the *J. J. Hill.* The dimensions of this type of vessel are: Length, over all, 500 ft.; beam, 52 ft.; depth, 30 ft. The estimated carrying capacity is 8,000 tons, on a draft of 18 ft. These vessels are equipped with quadruple expansion engines, water tube boilers, automatic stokers, and a complete outfit of auxiliaries and deck appliances. Another vessel of the same dimensions will probably be launched from the same yard this month.

S. S. G. W. Dickinson.—A new steamer built for the Pacific Clipper line to enter the Cape Nome and Alaska trade, was launched by Moran Bros., Seattle, Wash., April 16. This is the largest wooden vessel ever built in Seattle, measuring about 215 ft. in length and 1,200 tons gross tonnage. She was built to carry passengers as well as freight, and has accommodations for about 300 in her cabins. She is fitted with engines capable of giving the vessel a speed of about 10 knots. It is understood that this boat will be purchased by the Government for service in the Army transport department. The steamer is reported to have cost about $140,000.

Tug John K. Cowen.—At the yard of the Spedden Shipbuilding Co., Baltimore, Md.. the tug *John K. Cowen* was launched April 19. The tug is built of steel and is to the order of the Baltimore & Ohio Railroad. Her dimensions are: Length, 110 ft.; beam, 22 ft.; depth, 13 ft. The machinery will be capable of giving the tug a speed of 14 miles when running free. The machinery will be fitted by the Neafie & Levy S. & E. B. Co. of Philadelphia. Another tug of about the same dimensions was laid down on the slip from which the *Cowen* was launched.

S. Y. Margarita.—The Watson-designed full-powered steam yacht *Margarita,* for A. J. Drexel of Philadelphia, was launched at the Scott yard, Greenock on the Clyde, April 30. This vessel was described in our issue of February last. Her dimensions are: Length, over all, 323 ft.; beam, extreme, 36 ft. 7 in.; load draft, 16 ft. 8 in. She will have twin screws, triple expansion engines, and a trial speed of about 17 knots. Her cost is said to be not less than $750,000.

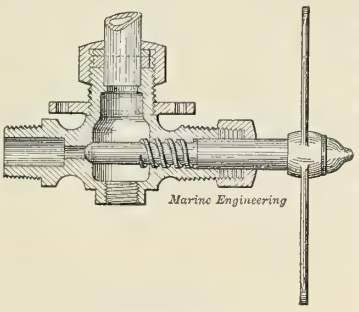
S. S. Robert W. E. Bunsen.—At the yard of the Chicago Shipbuilding Co., South Chicago, this addition to the Bessemer fleet was launched May 15. The new vessel is of the regular lake type of ore carrier and is of these dimensions: Length, 460 ft.; beam, 55 ft.; depth, 29 ft. She will carry 7,500 tons of ore on 18 ft. draft.

Barge Georgia.—A coal barge with a capacity of 3,000 tons for the Coastwise Steamship Co., of New York, was launched at the New England Shipyard, Bath, Me., April 30. The barge is built of wood, and is fitted with steam auxiliaries, including Hyde windlass and wrecking pumps.

Sch. Bainbridge.—A 4-masted wooden schooner for the Pacific coast lumber trade was launched at Hall Bros.' yard, Port Blakely, in May. The new vessel has a capacity of 800,000 ft.

IMPROVED APPARATUS.

Quick-closing Water Gauge.



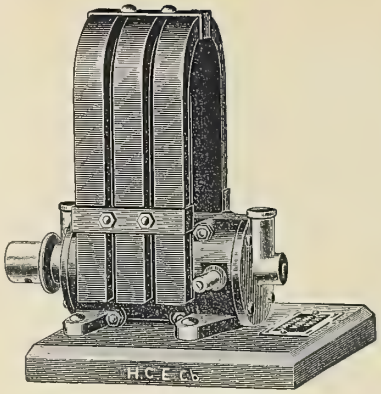
SECTION OF COCK.

An improved form of safety gauge glass mounting is shown in the sectional engraving of the "P. B. H." quick-closing water gauge. The glass is carried in the usual way in large stuffing boxes with screw glands. The cocks which control the steam and water inlets to the glass pass through stuffing boxes in the front of the water gauge, and are fitted with T handles. The ends of each handle, top and bottom, are connected by a chain, which is carried down sufficiently low so that it can be easily reached by the fireman. These cocks are fitted with solid plugs, the inside ends being rounded and seating in the passage between the glass and the boiler or water column. The plugs are threaded with a quick square thread, so that a very slight movement of the outside arm is sufficient to fully open or close the outlets. As the ends of the chains are hooked into the ends of the plug handles and the chain looped down, the cocks can be opened or closed separately or together, as desired. There is no automatic device about this gauge such as is often depended upon to act in emergency and fails to do so. It is positive in its action, and being constantly operated while a boiler is working, it is always in good condition and ready for an emergency. In case of failure of a glass the steam and water can be cut off almost instantly, and a glass replaced without any delay while a full head of steam is on. The new style gauge is manufactured by Paul B. Huyette, 1225 Betz Building, Philadelphia.

Gas Engine Igniter.

In motor boats trouble is often experienced with the batteries used to produce the igniting spark in the engine. To obviate this the Holtzer-Cabot gas engine igniter has been designed. The machine is constructed with a permanent magnet field and an armature of the drum type, similar to that used in direct current motors. It has self-feeding carbon brushes, and is self-lubricating, being provided with grease cups. This igniter is especially adapted for marine work; the armature, being enclosed, is dirt, oil, and moisture proof. It can be run in either direction, and if the fly wheel of the engine runs true, the igniter may be driven from a friction pulley bearing upon the wheel, or may be belted to the fly wheel or to any convenient shafting. The speed should be about 2,000 revolutions, but it can be run at any speed, from 1,500 to 2,000 R. P. M. A battery, consisting of four or five cells of any ordinary circuit form, is used, but for a few minutes, merely to start up the engine, and will consequently last indefinitely. In addition to a spark coil which must be placed in circuit

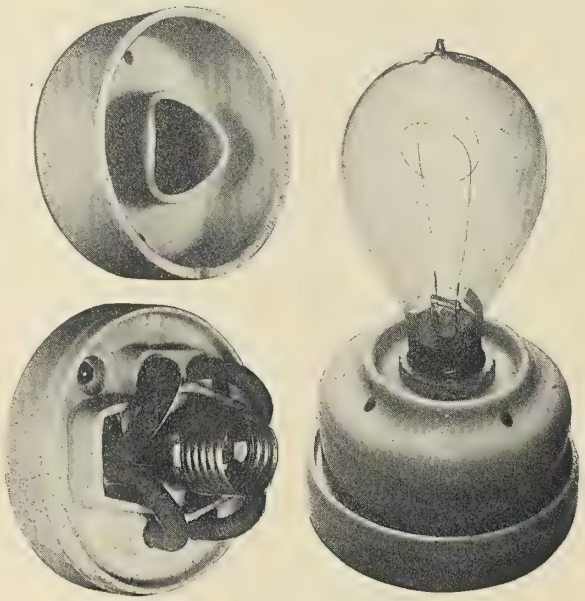
with the igniter, the use of the automatic switch is recommended for cutting the dynamo into circuit when it has reached a sufficient speed or voltage to produce a good spark. An ordinary two-point switch should be included in the battery circuit to prevent leakage in case the contacts in the engine cylinder remain closed when the engine is shut down. A similar igniter is also made under the name of the "automobile type," which measures only 7 1-2 in. high, 4 in. wide, 7 in. long. These igniters are manufactured by the Holtzer-Cabot Electric Co., Brookline, Mass.



HOLTZER-CABOT IGNITER.

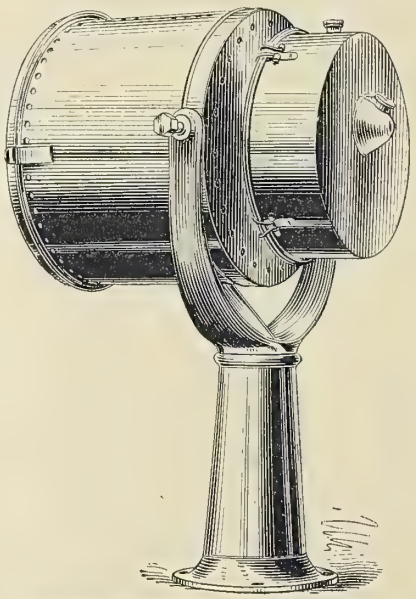
Neptune Marine Receptacle.

Any one who has had experience with ship lighting is familiar with the fact that water, that great enemy of electrical apparatus, will put in an appearance at the most unlooked for places. It frequently happens that a vessel will ship a big sea, or a bath tub will run over; in fact water will find a passage in a multiplicity of ways into the grooves in which the electric conductors are located. Lamp fittings being attached to the ends of the wires always form the outlets for the stray water and are invariably destroyed if they are not of the water-tight type. Heretofore watertight electric fittings have always been made of metal with a watertight glove, and the ingress of water has been prevented by means of watertight stuffing boxes, using soft rubber bushings. Such lamp fittings cannot be used exclusively on a ship on account of their great cost and their unsightliness, and so as a rule have been applied only in the engine room and fire room. The Neptune waterproof receptacle here illustrated is built upon a new principle, inasmuch as it is not a watertight fitting, but a waterproof device, and cannot be injured thereby, even if the water should run into the interior of the receptacle. The water is shed before it can reach any of the vital parts, which are the metallic connections. Thus short circuits and deterioration are absolutely prevented. The principle of the device to accomplish this result is very simple. It consists in arranging the interior so that the water will run off in a bight or loop of the conductors through holes provided in the cap. The base and cap also have suitable barriers and bosses to help bring about the above result. This new device is manufactured by the Electro Dynamic Co., 224 Ionic St., Philadelphia, Pa.


NEPTUNE MARINE RECEPTACLE.

Baldwin Acetylene Searchlight.

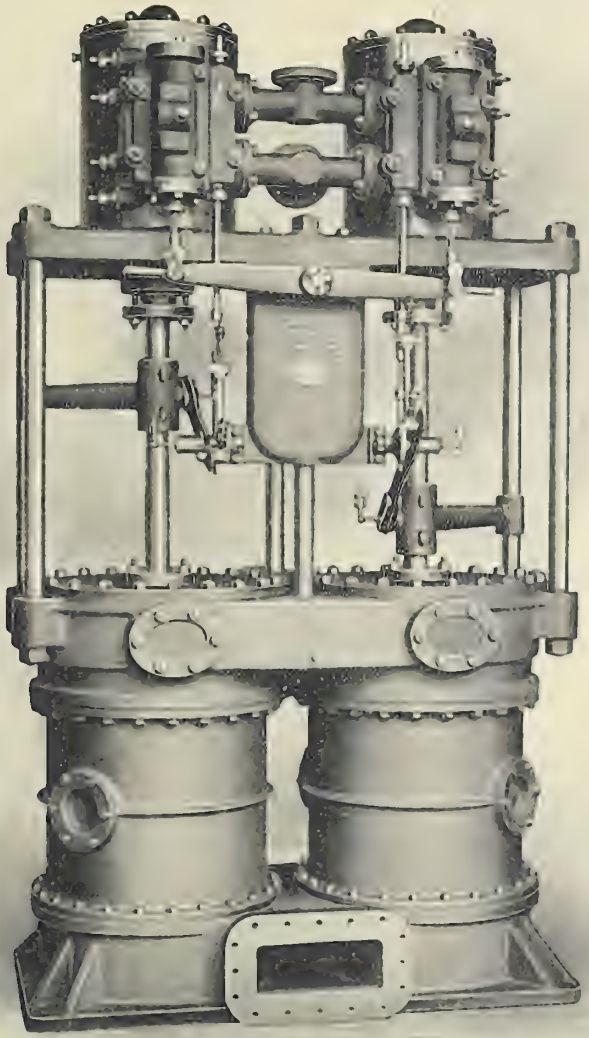
The Baldwin acetylene searchlight is a compact, self-contained form of projector designed especially for use in small yachts and launches. It is very simple in its mechanism, and is manufactured in tasteful style, so that it is a very sightly addition to the equipment of a small vessel. It is self-contained in the strict sense of the term, as no extra tank or generator is necessary, and as it is all in the open air there is no possibility of any escape of gas in the living quarters. The total height of the lamp is 16 in., the reflector being 8 in. dia. In small launches it is placed in the bow, and is operated by a handle on the back. For cabin launches or yachts an extra attachment is made, so that the lamp can be controlled by one hand only. The cost of operation is stated to be very small, and the light is sufficiently powerful so that objects can be picked up at


BALDWIN ACETYLENE SEARCHLIGHT.

a distance of several hundred feet. This searchlight is made by A. H. Funke, 101 Duane St., New York City.

Independent Air Pump.

The engraving herewith shows Dean Brothers' Twin Cylinder Air Pump with patent steam valve gear. This mechanism so controls the pistons that they will always move synchronously in opposite directions and invariably work to the full limit of their stroke. Should one piston move faster than the other, and therefore reach the limit of its stroke in advance of the other it will wait until the second piston reaches the opposite limit of its stroke, when both pistons will simultaneously reverse their motion. The necessity of a beam connecting the two piston rods is obviated, and the friction of the beam and its numerous connections avoided. Where a beam is used there must be cross heads, slides, pins, joints and other complications that not only produce friction but are also in danger of breaking or derangement. Dean Brothers' twin cylinder air pump may be operated in three ways. (1) The two pumps may be operated in conjunction as above stated. (2) By detaching the lever that connects the chest pistons the pumps may be run independently. (3) By disconnecting both the chest piston lever and the steam valve rod of one pump its operation will be stopped while the other pump will continue to operate. If from any cause one pump is disabled the other one may be run until repairs can be made. This is the only twin cylinder air pump made that is convertible into separate pumps. The marine engineer will appreciate this feature, as the stoppage of an air pump at sea is a serious matter. The piston rods are separable at the cross heads. The cross heads are of steel. The steam cylinders and pump cylinders are connected by six heavy steel stretcher rods. Adjusting valves are fitted to steam cylinders for controlling the motion of the pistons. The valve gear is provided with patent lever adjustment, by which the length of stroke of pistons may at any time be changed, even while the pump is running. This style of pump is manufactured by Dean Bros.' Steam Pump Works, Indianapolis, Ind.



DEAN TWIN CYLINDER INDEPENDENT AIR PUMPS.

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

MANY and conflicting rumors concerning a probable seismic disturbance in the construction departments of the British Navy have been in circulation lately. It is said with some pretense of authority that the Director of Naval Construction, Sir William H. White, will resign, as he is not in accord with other chiefs regarding designs for new vessels, and for the further reason that he feels keenly the responsibility for the botched construction of the Queen's yacht. The reason first given is the more plausible, for —if there is any foundation at all for the rumor— the matter of a mistake in calculations, made no doubt by a subordinate, would hardly be likely to cause the resignation of so able a chief constructor. Mistakes will occur in shipbuilding just the same as in other industries—not simply errors of judgment or failure of careful design to give results expected, but gross errors that are inexcusable—errors in simple addition, possibly. Elsewhere in this issue we report a case tried before the House of Lords in which errors in calculation made by a draftsman for an eminent firm of shipbuilders have cost his employers the large sum of $80,000. But to return to the British Navy. Rumor extends the area of upheaval to the Department of Steam Engineering, of which Engineer-in-Chief Sir Albert J. Durston is the head. The well informed *Pall Mall Gazette* gives voice to the rumor in its issue of May 9 last as follows:

> We have reason to believe that an important change is impending in the policy of the Admiralty on the boilering of the ships of the Royal Navy. We have argued for a long time past, on the evidence that was collected in the columns of the *Pall Mall Gazette* early last year, that the wholesale adoption of Belleville boilers for our battleships and cruisers was a grave error of judgment. Experience has proved that this contention was at least well founded, and we believe that the Lords of the Admiralty have at last recognized this. Their conversion has been assisted not a little by the record of the *Powerful*, which crept home from the Cape at less than half her designed speed, and will now have to be practically eviscerated before she can be recommissioned for service.
>
> If, as we are given to understand, the Admiralty are now convinced that it would be dangerous to rely on this type of boiler in time of war for other than torpedo craft, the naval service will welcome the fact with immense relief. But the change of policy involved will necessarily cause the Lords of the Admiralty to revise the personnel of the consultative engineering branch. Several important changes are, we believe, in contemplation, and with them it may be expected that a reform vitally affecting the efficiency of the Fleet will be commenced immediately. As a preliminary, it would be desirable that a committee of experts should at once be appointed to examine the whole boiler question.

From this it would seem that the boiler fight which waged with extraordinary fierceness across the water some years ago might be reopened. It is not likely that the advocates of the water tube boiler will allow any return to the older tank boiler, though at the same time it is not unlikely that influences are at work to discredit the Belleville boiler and substitute for it some form of water tube boiler native to the soil. The authority quoted above is manifestly in favor of the tank boiler, as it says: "The Admiralty are now convinced that it would be dangerous to rely on this type of boiler in time of war for other than torpedo craft." As the Belleville is, of course, not used in torpedo boats, the reference to "type" must mean the water tube type in all its forms. The proposition, therefore, that the water tube boiler cannot be relied upon in time of war, and by inference that it can be relied upon in time of peace, is a novel one. It is, we believe, generally held that one of the chief advantages of the water tube type is its adaptability to war conditions. Our own Engineer-in-Chief, George W. Melville, in his splendidly practical paper on the subject, read before the last meeting of the So-

ciety of Naval Architects and Marine Engineers, gives as chief among the reasons for the adoption of the water tube boiler in the United States Navy that "water tube boilers give tactical advantage of great movement." He cannot be called a biased advocate of this type of boiler, for he recognizes its disadvantages, but shows that these may be neutralized in "selection, manufacture and management." So far from being an opponent of the tank boiler, he says: "It is at best a moot question whether cylindrical boilers are not still the best that can be fitted in ocean-going merchantmen." With the great experience which our Engineer-in-Chief has had with widely differing types of water tube boilers in the Navy to assist in forming his judgment, and with the entire absence of prejudice where the tank boiler is concerned, it would need some argument more convincing than the failure of the *Powerful* to reach expectations to cause designers to decide against the adoption of water tube boilers for naval vessels. As a matter of fact, it has always seemed as though the British were not as skilful in boiler as in engine construction and maintenance. This has been so notoriously in the British Navy. The merchant marine is another story. Repeated failures of cylindrical boilers in British war vessels greatly hastened the adoption of the water tube boiler, the Belleville being championed by Sir A. J. Durston, and fitted in a large number of the finest ships in her navy. One of the reasons (and probably the correct one) given for the failure of the cylindrical boiler was that many of the older ships of the British Navy were underboilered, and in those days forced draft was not as well understood as now. At one time, indeed, leaky tubes in the back connections threatened disaster to the British fleets and thus caused the adoption of the famous "Admiralty ferrule." The troubles in the British Navy did not end with the adoption of the water tube boiler for the larger vessels. The earlier boilers of the Belleville type were not fitted with economizers, and the coal consumption figures were high, and then a more direct cause of alarm was the frequent failures of lap-welded water tubes, with, in some instances, attendant loss of life. Since the introduction of the economizer and the solid drawn steel tube it was generally supposed that a satisfactory solution of the trouble had been reached. Apparently not, and the next move will be watched with the very greatest interest by the entire marine engineering world.

A MEMORANDUM of the chief characteristics of the three sea-going coast line battleships for the Navy, authorized by act of Congress of March 3, 1899, has been issued. It will be recalled that the act providing for the construction of these ships placed such restrictions upon the matter of armor plate to be provided for them that, as a consequence, contracts for the vessels could not be let, and the situation will so remain until Congress shall settle the armor plate dispute. This delay has been taken advantage of by the Bureau of Construction to carry out model experiments for the proposed battleships, the new tank at the Washington navy yard being utilized for the first time in such work. The designs are thus very well thought out, and the only question of structural detail yet not finally settled is that of the arrangement of the main battery. Advocates of the superimposed turrets, as employed in the *Kearsarge* and the *Kentucky*, have insisted that the new vessels be similarly equipped. A majority of the Board of Construction, however, with very commendable conservatism, agreed upon the more usual form of arrangement of battery, leaving a clause in the circular that permits the adoption later of the superimposed system if it is considered advisable. Considering that the system, as adopted in the case of the *Kearsarge* and the *Kentucky*, is an absolute novelty and has simply had a few acceptance tests, as it were, and no extended trial under service conditions, it seems as though the premature and wholesale adoption of the system would be a grave mistake. The new ships will be named the *Pennsylvania*, the *New Jersey*, and the *Georgia*, and will be of these dimensions: Length on load line, 435 ft.; beam extreme, 76 ft.; trial displacement, 14,650 tons; mean draft at trial displacement, about 24 ft.; maximum draft, fully loaded, about 26 ft.; total bunker capacity, 1,900 tons; coal carried on trial, 900 tons; feed water on trial, 66 tons; speed not less than 19 knots. The armament will include four 12-in. breech loading rifles, eight 8-in. ditto, twelve 6-in. rapid-fire rifles, twelve 14-pdrs., twelve 3-pdrs., four 1-pdrs., all of the rapid-fire type, and also two 3-in. field pieces, two machine and thirty automatic guns. The propelling engines will be of the four cylinder, triple expansion type of 19,000 collective horse power. Water tube boilers will be installed, arranged in groups, each group in a water-tight compartment. The armor protection will include a complete belt at the water line of a maximum thickness of 11 in.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—FIREROOM—I.

BY DR. WILLIAM FREDERICK DURAND.

ROUTINE AND MANAGEMENT.

In the present section it is the purpose to give brief hints and suggestions regarding the routine of operations in the fireroom in getting under way and on the voyage, supposing that everything is working smoothly and without trouble. We shall first suppose that fire-tube boilers are in use, and later give such supplementary suggestions as may be suitable for water-tube boilers.

A general examination must first be made of the boiler and fireroom equipment in order to make sure that everything is in readiness for getting up steam. Among the more important points to be attended to the following may be mentioned:

See that the coal bunker doors are in proper working order and if the bunker is partly empty it may be well to air it by opening the door and taking off the deck plates.

See that the coal handling gear is on hand and in proper condition.

See that the necessary fire tools are provided, and distributed as needed.

Examine the grate-bars, bridge-walls and back-connections, and note whether the area of passage above the bridge-walls is properly proportioned. For usual conditions it should be from 1-5 to 1-7 the grate area.

Note the condition of the tubes both from the front and back connections.

Examine the dampers in uptakes and funnel to see if they are in working order, and open them preparatory to lighting the fires.

Examine carefully all valves, cocks, piping and connections and make sure that everything is connected up as it should be, and that no valves are open which should be closed nor closed which should be open.

See that no waste or other inflammable substances have been left about by workmen on the tops of the boilers.

If the water has not been previously run up in the boilers, this may be under way in the meantime. In modern practice the boilers are always filled with fresh water where possible, obtained from a hydrant on the dock or water boat alongside, and put in usually by a hose through an upper manhole. If, however, the boat is lying in fresh water, or if by necessity the water is to be taken from over board, it is then run in through the bottom blow and Kingston valve. In the meantime examine the connections leading to the water-gauge and cocks. Clean the glass if necessary, and make sure by means of a wire that the opening through the cocks is clear. The packing of the gauge glass should also be examined and renewed if necessary. When the water appears in the gauge glass and shows from one-half to two-thirds full in each boiler, it may be shut off.

All open manholes may then be closed, and the boilers are ready for the fires.

Notice of the time when steam is required should have been given not less than from six to eight hours in advance, and many engineers prefer a still longer time in which to bring along everything into working condition. With hard coal a certain amount of wood is necessary in starting the fires. With soft coal less wood is required, and if necessary oily waste may be made to answer the purpose. If fires are up in the donkey boiler a little live coal may be taken from them to assist in starting. As soon as the fires are going the hydrokineters are put on if such appliances are fitted. In some cases arrangements are made for drawing the water by the donkey or auxiliary feed-pump from the bottom of the boiler by the bottom blow and returning it through the feed-pipe, thus producing a forced or assisted circulation. Where there are no appliances for forcing the circulation during this period, it is considered good practice to light first the fires in the center furnaces, and later, by one or two hours, those in the wing furnaces. The natural circulation thus produced will more nearly even up the temperature within the boiler than if all fires are lighted at the same time. After the fires are fairly going the funnel or uptake dampers may be partly closed so as to hold the fires back, and bring them along at a moderate gait as desired.

While the boilers are thus warming up and before steam has formed, a last look may be given to the boiler mountings and their connections. The various cocks and valves should be worked, and especially the stop and safety valves, in order to make sure that none are jammed or in any way out of order. The oil lamps for the steam and water gauges may also be trimmed and lighted, or the electric bulbs cleaned, if such are provided.

During this period the steam-pipe drains and safety valves are usually open to allow of the escape of the air and of the condensed vapor as formed. In some cases, however, the safety valves are closed, and the stop valves being open, the air and vapor are expelled along the steam-pipe and through the engine, thus beginning the process of warming up. Many engineers, however, prefer to keep the boiler stop valves closed until steam is formed, and to discharge the air through the safety valve, or in some cases through a specially fitted air-cock. If steam is already up on some of the boilers or if there is no auxiliary steam-pipe and the pressure from the donkey boiler is on the main steam-pipe, then of course the stop valves must be closed on the boilers in which steam is being raised, and they must remain closed until the pressure on the boiler is equal to that in the steam-pipe. In opening a boiler stop valve connecting with a pipe in which there is no pressure the following precautions should be taken:

(1) The pipe should be thoroughly drained and especial care should be taken that there are no sags, bends or U's unprovided with proper drains, and in which a pocket of water may have collected.

(2) The valve should be very carefully eased from its seat and opened only from a quarter to a half turn until the pipe is under full boiler pressure and has taken the temperature of the steam, and the drains are discharging steam instead of water. In opening a boiler stop valve connecting with a pipe in which there is approximately the same pressure as in the boiler, it is simply necessary to ease the valve from the seat and note by the sound whether there is a sufficient differ-

ence of pressure to cause any violent flow in one direction or the other. As soon as the absence of such evidence indicates an equality of pressure on both sides of the valve, it may be opened out as desired.

The two fundamental principles underlying much of this routine and detail are simply as follows:

(1) To prevent as far as possible *sudden* changes in the temperature condition of the boilers, piping and machinery, and

(2) To prevent throughout the steam-pipe system the accumulation of water at any point.

If these two points are kept clearly in view and good engineering judgment used in carrying them out, the life of the boilers and machinery will be prolonged, and danger of ruptured pipes through the effects of water hammer will be avoided.

After steam is formed and the pressure has risen to some 40 or 50 lb. the hydrokineters may be shut off, especially if the ship is to get under way as soon as ready. If, however, the boilers are to stand some time with steam up, it may be advisable to turn on the hydrokineters from time to time, at least as long as the pressure in the donkey boiler is sufficient for the purpose.

The fires in the meantime have been kept simply in good condition without forcing, and even if they work under a forced draft system, only enough air should be provided during this stage to bring them along at the gradual pace which will allow the boiler to properly accommodate itself to the change in temperature and other conditions.

The fire-room auxiliary machinery should also be examined during this period, and tested under steam from the donkey boiler if possible. The feed pumps should first receive attention, in order that there may be no question as to the proper supply of feed-water when required.

The fan engines should be examined, oiled and turned over under steam.

The ash-hoist gear and engine, or ash ejector and pump, should be examined and put in working order.

If steam for these purposes is not to be had from the donkey boiler, then as soon as a sufficient head is formed on the main boilers these auxiliaries must be examined, taking in all cases the feed pump first.

Soon after lighting fires it may be desirable to slacken up somewhat on the funnel guys on deck, in order that the expansion of the funnel may not bring an undue stress upon the guys and their connections, or upon the funnel and its supports. After the ship is away and the funnel has taken its temperature for running conditions, the guys may be tightened up so as to properly support the funnel in a sea way.

At length we may suppose that full head of steam has been formed on the boilers, that the fires have been brought up to proper condition, and that the ship has gotten under way for the voyage. As soon as possible the operations in the fireroom should be brought to a regular routine. This will involve the following chief features, which we shall consider separately: (1) Firing. (2) Water tending. (3) Disposal of ashes. (4) Cleaning fires. (5) Sweeping tubes.

Firing. The routine of firing should be so arranged that no two furnaces in boilers connected to the same stack shall be open at the same time. If this is not practicable, then care must be taken to avoid at least firing at the same time furnaces in opposite ends of double end boilers, especially if there is a common combustion chamber. Two furnaces in a single end boiler, or in the same end of a double end boiler will, of course, never be fired at the same time. It is now well understood that firing light and often is better than heavy and at greater intervals. There is, however, a limit to this, for the oftener the firing the more are the furnace doors open and the more is the draft subject to disturbance, while the arrangement of a suitable routine becomes more and more difficult.

Light and frequent firing, especially with water-tube boilers, is now, however, the rule where the best results are to be obtained. The furnace door should be opened smartly and kept open only the minimum time needed to get the coal on. Hard coal is spread in as even a layer as possible over the grate. For firing soft coal two methods are available. When firing for coal efficiency, that is to get the most heat out of a pound of fuel, the coal should be first charged in front and coked, and then should be pushed back and burned. When firing for weight efficiency, that is to get the most power out of the boiler, the former method would be too slow and the coal must be spread over the fire and burned without waiting for the separate distillation and combustion of its gases. Where the coal runs irregular in size the large lumps should be broken into pieces not larger than the fist. The thickness of the fires varies with the conditions, from six to ten or twelve inches, or even thicker under a heavy forced draft. With a given speed of fan the air pressure in the ash-pits will vary widely with the thickness of the fire, rising as it is thicker, and falling as it is thinner and the air finds more ready passage through. With a thick fire it will therefore be easy to get a strong draft pressure in the ash-pits, while with a thin fire it will be perhaps impossible, even with a much higher speed of fan. A strong draft pressure will not, however, produce the corresponding rate of combustion unless the thickness and condition of the fire are such that the pressure is able to drive through it the necessary amount of air. For the best combustion the thickness of the fire should be so adjusted to the draft pressure that the latter is able to drive the necessary air through, and keep it in a state of active combustion throughout from fire grate to upper surface. Care must be taken to keep the grates evenly covered, especially at the back, and to prevent the formation of relatively thin or bare spots. A spot which is relatively thin allows of the passage of relatively more air. This further increases the combustion at that point and the spot becomes still thinner, thus allowing more and more air to escape freely instead of passing through the remainder of the fire as it should.

In the intervals of firing the pricker and slice bars may be used to clear away the ashes and clinker, if such is forming. Care should be taken to prevent the formation of dull or dead spots due to the accumulation of ashes or clinker, especially at the corners of the grate. Among old firemen a familiar saying relating to this point is: "Take care of the corners and sides of the fire and the middle will take care of itself."

The ash-pits should also be kept clear of ashes, for if allowed to accumulate they will prevent the passage of air to the grate, especially at the back. If the passage of air is thus interfered with to any considerable extent there will be also danger of overheating the grates and of bringing them down into the ash-pits.

In connection with the use of the slice bar, it must not be forgotten that every opening of the furnace door means an inrush of cold air into the furnace, a checking of the draft, a disturbance of the combustion, and often severe strains on the structure of the boiler, due to the sudden chilling and contraction which the heating surfaces undergo. If shaking grates are fitted much of this cleaning may be done without opening the door, though no form of grate is quite able to deal satisfactorily with coal showing a decided tendency to form clinker.

In thus working the fires a certain amount of fine unburned or partly burned coal will be shaken down into the ash-pit. In some cases this forms so large a part of what comes through the grate, that it may be immediately thrown on to the fire and burned over again. In most cases a sifting or washing of the ashes and separation of the combustible from the non-combustible would show a surprisingly large per cent to be available as fuel, and some saving could usually be effected in this way. It is rare, however, that anything of the kind is attempted, as with present prices of coal it may be doubted whether the additional appliances and labor would be paid for by the saving effected.

ENGINEERS' DICTIONARY.—XXVIII.

Mean Effective Pressure—By the *effective* pressure we understand the resultant of two pressures acting in opposite directions, as for example, one on the bottom of the piston acting upward, and one on the top acting downward. The *mean* effective pressure will then be the mean resultant of such pressures for a stroke or for a revolution. Referring to Fig. 88 the mean forward pressure (say downward) will be given by the mean of the ordinates from the line of zero pressure *R S* to the upper boundary of the card *A B C D*, while the mean back pressure (upward)

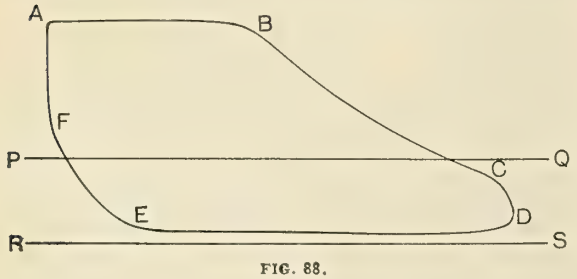

FIG. 88.

will be given by the mean of the ordinates from *R S* to the lower line of the card *F E D*. The mean resultant or mean effective pressure will then be given by the difference between these two means, one down and the other up. This result will therefore be given by the mean of the vertical heights of the diagram itself, or in other words, by the mean vertical height of the diagram. This is obtained by dividing the area by the length, and reducing the mean height thus expressed in inches, to pressure according to the scale of the diagram. The term mean effective pressure is often expressed by the abbreviation m. e. p. The use of the m. e. p. in the computation of the indicated horse-power is explained under HORSE-POWER.

Metallic Packing—With the common use of steam of higher and higher pressures, the various forms of fibrous packing for piston and valve-rods have become more and more unsatisfactory, and in modern practice metallic packings have come into almost universal employment for all such cases. There are many different forms of metallic packing, but in nearly all the fundamental features are similar, and consist in the use of

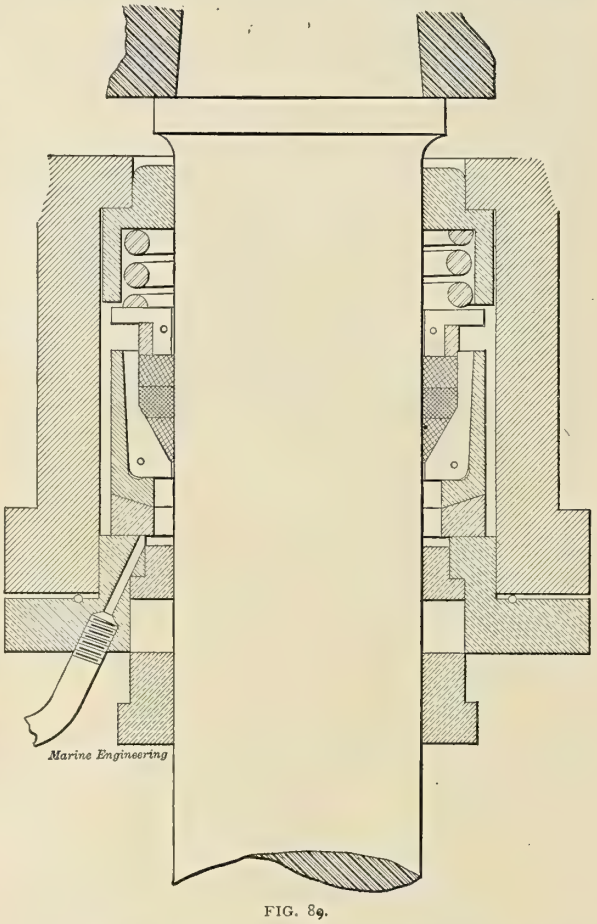

FIG. 89.

rings of white metal or other bearing alloy, cut in sections and carried or supported by rings of brass or other like material. They are also frequently arranged so that springs of one form or another will bear on the rings and force them into contact with the moving rod, and thus secure the pressure between the rings and the rod necessary to make a tight joint. In Fig. 89 is shown a representative form of metallic packing, made specially for use with high-working pressures.

Among the large American owned steam yachts recently fitted out for cruising in European waters are the *Sultana*, 390 gross tons, John R. Drexel, owner; the *Alcedo*, 552 gross tons, George W. Drexel, owner; and the *Aphrodite*, 1,148 gross tons, Col. O. H. Payne.

TECHNICAL PUBLICATIONS.

STANDARD DESIGNS FOR BOATS OF THE UNITED STATES NAVY. By Chief Constructor Philip Hichborn, U. S. N., Chief of Bureau of Construction and Repair. First Edition, 1900. Government Printing Office, Washington, D. C. Size, 15½ by 13. With 221 plates.

This publication, in the language of the bookseller, is a "monumental work." It is one of those rare technical publications that will endure for all time, possibly long after the period in which the apparatus it describes is used by mankind. It is a collection of specifications, schedules of material, weights, and costs, of each and every type of boat now used in the United States Navy. The data is really exhaustive. In the specifications are included the sizes of every bit of material which enters into the construction of a Navy boat; scantlings, fastenings, spars and sails being in turn given in detail. The schedules of material, labor, itemized weight and cost are very minute and complete to a ten-penny nail. In the case of steamboats, the general description of the machinery gives the principal dimensions and type of apparatus employed. In addition to these details there are large scale drawings of the lines, mould loft dimensions, profiles, plans and sections and detail drawings, so complete that not a single word of explanation would be needed for the builder to produce the complete boat. Each type is also illustrated in different positions by fine half-tone engravings.

For a long time the Construction Bureau labored to standardize the Navy boats, and it has finally achieved this desirable result. Now the assemblage of this data in one cover will enable any competent boat builder, in case of emergency, to turn out Navy boats in the briefest possible time—boats in which the fittings will be interchangeable.

The value of a publication of this sort is greater than the special information which it contains. It is one of those instruments that makes for progress in every direction, that impresses the builder with what can be accomplished by systematic work in what at first would seem to be a relatively unimportant field. It also sets a high standard for the recorder of progress in marine construction, and is an expression of that liberal exposition of methods that has always been associated with the profession of engineering in America. No private individual or concern could, of course, produce such a work with any hope of return of the capital invested, not to speak of profit. In this connection it is a matter of slight regret that the double plates were not inserted so that they could be stretched out flat for examination, and that a better quality of paper and ink was not used for the text pages. The book is such a splendid collection of data that the Government printer might well have striven to have reached in his work the standard of excellence set by the distinguished author.

MACHINISTS' AND DRAUGHTSMAN'S HANDBOOK. By Peter Lobben, M. E. First edition, 1900. D. Van Nostrand Co., New York. Size 5 1-2 by 8. Pages 438. With drawings. Cloth, $2.50.

This is a compilation intended as a reference book for all who are interested in mechanical work. The first part is devoted to the rudiments of arithmetic, algebra, geometry and geometric drawing, mensuration, and weights and measures, compiled in a manner to be of assistance to a mind not trained in technical matters with the view of applying the rules to the mechanical problems explained further on. Next is a chapter on strength of material, with tables, and a chapter on mechanics, in which the elementary principles are discussed. Following this is a chapter on the power required to drive different kinds of machinery and shop tools and the necessary speeds, and different problems on belting and various kinds of power transmission and shafting are explained. The article on gear teeth, bevel gear, and worm gear is very complete, and will be appreciated by those who contemplate the study and the laying out of gears.

COMPOUND ENGINES. By F. R. Low. First Edition, 1900. Power Publishing Co., New York. Size 5 1-2 by 8 3-4. Pages 52. With many diagrams. Cloth, flexible cover, 50 cents.

This pamphlet is a collection of "lectures" or papers published in *Power*, and intended to give in the clearest and simplest language the fundamental principles of the theory and operation of compound engines. The author has had a long and successful experience in presenting engineering facts in the simplest manner, and especially for those not acquainted with the higher mathematics. The present work seems in general to come up to the high standard already set by the author in this field of engineering literature.

In Lecture XIV the author discusses at length and in an interesting manner the question of receivers, joining issue to some extent with Seaton regarding the size of receiver suitable for engines with various crank angles, and in particular regarding the question whether an engine with cranks at 180 deg. may properly be given a smaller receiver than one with cranks at 90 deg. or 120 deg. It is probably true that Seaton has somewhat exaggerated the extent to which the receiver of a compound engine with cranks at 180 deg. may be decreased, and it is true that with equal points of cut-off in both high and low pressure cylinders the variation of pressure and temperature in the high pressure is in general independent of the crank angle, and in particular it will be the same whether the cranks are at 90 deg. or 180 deg., or at least such will be the case so long as the high pressure is exhausting at the instant of low pressure cut-off. It may be remarked on the other hand that with marine engines, the type to which Seaton especially refers, the points of cut-off are never found as early as 1-4 stroke (the point assumed in the present pamphlet), but rather at values of .6 to .75. Under these circumstances the variation of pressure will not be as wide as with the earlier points of cut-off, and the question of the volume of the receiver is of relatively less importance.

Further in the actual engine the distribution of pressure and of work does not, of course, go in quite so simple a manner as indicated by the computations given. Such computations can only give a first approximation to the actual facts of the case. There are many secondary influences which affect the result, and in general in such manner as to decrease the variation of pressure and temperature.

Taken as a whole, this collection of lectures or talks contains a large amount of valuable information relating to compound engines, and put in such a way as to be of interest and real help to those who wish an elementary presentation of the subject. The text is excellently supplemented by a large number of diagrams and engravings, specially prepared for the purpose.

Popular Science Monthly, for nearly thirty years published by D. Appleton & Co., has recently passed into the hands of McClure, Phillips & Co., of New York, and is now edited by J. McKeen Cottell, of Columbia University. The new owners propose to keep this monthly abreast of the needs of the day, of value to both men of science and the general public, and as an earnest of their intentions, they publish a magnificent list of American scientists who will be numbered among the contributors. Already the appearance of the publication has been greatly improved, though it seems a mistake in this busy age to put out a magazine with uncut pages. This is a remnant of old fogeyism that will not be appreciated by the up-to-date reader. There was formerly supposed to be some sort of connection between untrimmed books and deep learning, a sort of combination of erudition and inconvenience, but the busy professional inquirer cannot see the advantage of a repeated use of the paper knife when one stroke of the binder's guillotine would do the work. It is a waste of energy that might far better be utilized in absorbing the contents of the papers. There is a splendid future for this publication so long as science is not popularized into absurdity or degraded by sensational exaggeration. Neither would the other extreme of dry-as-dust discussion be likely to hold a wide circle of readers. Judging by the present issue the happy medium has been attained. The subscription price is $3 a year.

Brown's Pocket Log and Diary for Marine Engineers is a useful companion. It contains ruled pages for engine and fire room data for every day in the year, which, if properly filled up, would give a collection of most useful facts. There are also useful trial trip and coal consumption tables, night signals of various lines, tide tables for European ports, diary, with separate space for memoranda for every day in the year; standing orders, station bills, weights and measures and other data, distance tables, etc. It is a compact little book and is sold at the low price of one shilling by James Brown & Son, 58 Great Clyde St., Glasgow, Scotland. Another publication by this house is Brown's Nautical Almanac, a book of more than 300 pages, which sells for one shilling and threepence by post. This book is invaluable to deck officers on vessels in the foreign trade, and especially to deep-water yacht masters. It contains a vast amount of information for ready reference.

A collection of sea and patriotic songs, by James Lowe Pilling, Master Mariner, entitled "The Keel of the Kearsarge," has been handsomely issued in pamphlet form by the author. It is dedicated to Rear Admiral Philip Hichborn, U. S. N., and is for sale by Robinson & Smith, 350 Dearborn St., Chicago.

S. Y. Shemara.—The steam yacht *Shemara*, owned in Leith, Scotland, has been chartered for the season by Henry C. Frick, of Pittsburgh. She is of these dimensions: Length, 188 ft.; beam, 26 ft.; depth, 15 ft.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Will you please answer the following questions:

(1) Will a single cylinder condensing engine do more work than a non-condensing engine of the same size, with the same steam pressure and point of cut-off, and why?

(2) Why is the low pressure cylinder of a compound engine larger than the high pressure cylinder?

W. H. S.

A.—(1) Yes. The reason may be put in a variety of ways. Perhaps the following will be as simple as any:

First suppose the engine non-condensing and consider a single stroke. On the steam side the steam enters up to the point of cut-off, and then expands down to exhaust opening, passing through a certain definite series or history of pressures from one end to the other, and giving a certain mean forward pressure which we may call p. On the exhaust side we shall have the movement of the piston opposed by the exhaust pressure, which will be two or three pounds above the atmosphere, or say 17 lbs. above the zero of pressure. Then the mean *net* pressure for the stroke will be p decreased by the 17 lbs. back pressure, or $(p-17)$.

Next consider the same engine with the same point of cut-off, but made condensing. On the steam side the steam enters as before and goes through the same history of cut-off and expansion, and has the same history of pressure and the same mean forward pressure. On the exhaust side the cylinder is now connected to the condenser, within which is a partial vacuum produced by the condensation of the steam by cold water and maintained by the air pump. The pressure usually maintained is from 2 to 3 lbs. above the zero of pressure, or some 12 or 13 pounds below atmospheric pressure, or, as we may say, some 12 or 13 lbs. of vacuum. The pressure within the cylinder on the exhaust side will then be reduced to only slightly above the same figures, and we may take it as 3 lbs. for the average. Hence the mean *net* pressure for the stroke will now be $p-3$ instead of $p-17$.

It is easy to see that in the cylinder itself, and for this stroke there has been gained an amount of work corresponding to a load of 14 lbs. acting on the piston through the length of the stroke.

This is not, however, quite clear gain, for the circulating and air pumps must be operated in order to supply the condensing water and maintain the vacuum, and the work which they require must be charged against this gain. It results, however, that the work thus required by the pumps is much less than the gain in the engine cylinder, so that there remains for the condensing engine a substantial increase in the work given per stroke and per minute.

(2) The purpose of the compound engine is to divide up the total expansion of the steam into two steps. The first is carried out in the high pressure cylinder by cut-off in the usual way. After the high pressure stroke is completed the expansion is then continued and completed by exhausting the steam from the high pressure to the low pressure cylinder, so that by the end of the low pressure stroke the steam which once filled the high pressure cylinder will now fill the low. Now it is clear that if the low pressure and high pressure volumes were the same there would be no expansion and no gain of work in this way. The change would be simply a shift of the steam from one place to another, but without change of volume or other conditions. Hence, to secure the desired expansion, the low pressure cylinder must be larger in volume than the high, and this is the reason why they are so made.

Q.—Can you kindly furnish me with the respective contract numbers of the Denver class of cruisers?

H. T.

A.—The *Denver* class of U. S. cruisers are officially numbered as follows: *Denver*, Cruiser No. 14; *Des Moines*, Cruiser No. 15; *Chattanooga*, Cruiser No. 16; *Galveston*, Cruiser No. 17; *Tacoma*, Cruiser No. 18; *Cleveland*, Cruiser No. 19.

Miss Helen Gould has donated the sum of $150,000 towards the construction of a magnificent new building for the naval branch of the Y. M. C. A., near the Navy Yard, Brooklyn, N. Y.